SCIENTIFIC AMERICAN SUPPLEMENT. No 1725

Entered at the Post Office of New York, N. Y., as Second Class Matter.
Published weekly by Munn & Co. at 361 Broadway, New York.
Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York

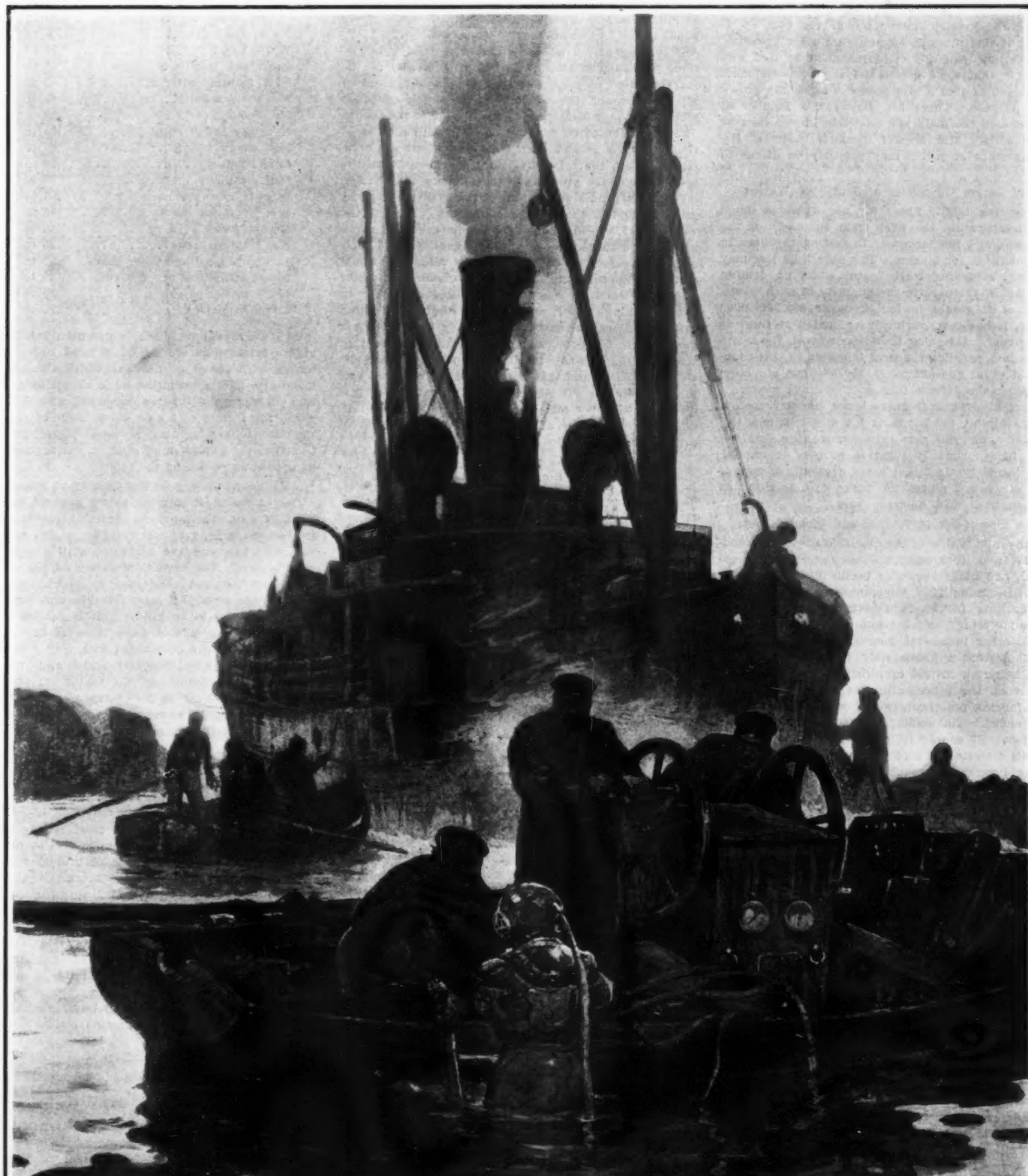




Scientific American, established 1845.
Scientific American Supplement, Vol. LXVII., No. 1725.

NEW YORK, JANUARY 23, 1909.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



The Sphere.

STRANGE SPOILS OF THE SEA. THE DIVER AND HIS WORK.

THE BRITISH NAVAL SCHOOL FOR THE TRAINING OF DIVERS.—[SEE PAGE 56.]

# PAPER-MAKING MATERIALS.—II.*

## SUGGESTIONS FOR THE MANUFACTURER.

BY F. P. VEITCH.

Concluded from Supplement No. 1724, page 44.

CONSERVATION OF PAPER-MAKING MATERIALS.

It is evident that more attention must be given in the future to maintaining sufficient supplies of materials to meet the legitimate demands of the paper-making industry. This is an agricultural and economic problem which may be met in several different ways, the essential consideration being that it shall be solved to the greatest advantage of the country at large. It is customary to suggest that other materials than those now generally employed must be used, and particularly that some new material or process must be discovered or that a crop must be especially grown for the purpose. There are, however, a number of ways in which the materials now best known may be made to satisfy still greater demands, some of the more important of which may properly be discussed here.

Use of Larger Quantities of Scutching Wastes.

In preparing textile fibers for use, there is much waste in separating the fiber from the body of the plant tissue, and further waste in getting the fiber in proper condition for market. The fiber thus lost may be termed "scutching waste," and while no definite figures can be given as to the quantity of such waste, as most of it occurs in barbarous or semi-civilized countries, it has been variously estimated at from 25 to 50 per cent. Assuming the lower figures, the waste from the jute, manila, and sisal imported to this country would equal approximately 150,000 tons annually, and would make 120,000 tons of high-grade paper.

The scutching waste from the hemp industry, though perfectly suitable for paper, is too small in quantity to play any material part in paper making, and the growing of it primarily for this purpose is impractical, owing to the fact that hemp even at the rate of 3 cents per pound makes the paper cost as much as that made from medium-grade rags.

Larger Use of Waste Textiles and Waste Paper.

Quantity and Value of Available Wastes.—Approximately 2,030,000 tons of cotton, flax, hemp, jute, manila, sisal, and other vegetable textile fibers are made into fabrics annually in this country, and all of this sooner or later in the form of cuttings, waste from the manufacturing processes, and rags, finally finds its way into other industrial uses or is destroyed. Statistics show that approximately 400,000 tons of this kind of material, 200,000 of which are imported, ultimately reach the paper mill, leaving about 1,800,000 tons of fabrics, practically all of which is destroyed. This is sufficient to make 1,440,000 tons of the very best paper. Of course it is not possible to recover all of this material. There is some loss in the manufacturing processes through which it passes and a great loss due to wear, but it is a conservative estimate to say that 1,000,000 tons of paper stock could be secured annually from this source alone, and at 1 cent per pound (rags sell at from 1 to 6 cents per pound) would be worth $20,000,000.

This 1,000,000 tons of waste textiles would make 800,000 tons of the strongest, most durable, and best paper, or more than enough to supply all the book, cover, plate, writing, high-grade wrapping, and blotting paper and bristol board now made in this country. There is a sufficient quantity of waste textiles to supply all demands for fine paper for years to come, and probably such papers will continue to be made from these materials, as no others which can compete with rags in cost are now known.

More than 3,000,000 tons of paper are now made annually in this country, of which fully 80 per cent, or 2,400,000 tons, becomes waste material in three or four years. Of this, about 25 per cent, or 588,000 tons, is again used in the form of new paper cuttings and trimmings and old paper for making new. Here also we estimate that fully 1,000,000 tons of raw material which would make 900,000 tons of paper could be readily saved from waste at a cost of collecting that would permit its use, as most of it is to be found in the cities and towns in the form of old books, writing paper, news paper, wrapping paper, and pasteboard. Most of this waste is not suitable for high-grade papers, but could readily be used for wrapping, cover, and blotting papers, and boards. The wholesale price of such paper ranges from $2 per hundred pounds for new high-grade cuttings to $1 for new white paper, and from 65 cents for folded newspaper to 20 cents per hundred for common scrap paper of any kind. Valuing the waste paper at 0.5 cent per pound, the 1,000,000 tons of paper now wasted that could be saved is worth $10,000,000 per annum, and would make all of the building, bagging, cover, blotting, and miscellaneous papers, and all the paper board now produced. Though the cost of raw material per ton of paper is slightly greater at the above valuation than when produced from wood, the cost of manufacture from waste paper is much less, so that the product made from waste paper is fully as cheap as that from wood.

Gathering and Grading.—A more general appreciation, particularly among the country people, of the market value of rags, old rope, and waste paper of all kinds would increase largely the supply of paper stock and add considerably to the income of the people. The value for paper making of the waste textiles of the country is greater than the value of the rye crop, one-twentieth that of the wheat crop, one-third of the total value of the products of the saddlery and harness industry, half as great as that of the hardware, and as great as that of the fur goods industry. Rags to the value of $9,000,000 annually are now used for paper making and about three times this quantity could probably be secured, which, at the same valuation, would distribute approximately $27,000,000 among the people; $7,000,000 worth of waste paper is used each year in paper making, but it is estimated that three times this amount can be saved, distributing $20,000,000 per year among the people. It is evident, therefore, that the value of the waste textiles and paper annually destroyed is large and that if these can be gathered profitably, their use will serve the double purpose of producing good paper and of conserving other materials.

The various grades of rags with their current prices are shown in the following table:

Market Grades for Rags, with Current Prices.

| | Cents per pound. |
|---|---|
| New shirt cuttings, No. 1 | 5½ to 6 |
| New shirt cuttings, No. 2 | 4 to 4¼ |
| Fancy shirt cuttings | 3⅞ to 4 |
| New blue cotton | 3 to 3½ |
| New mixed cottons | 1¼ to 1½ |
| Old linen: | |
| White | 4½ to 5½ |
| Gray | 2¼ to 4 |
| Colored | 1¾ to 2¾ |
| New black cotton: | |
| Soft | 1½ to 1¾ |
| Mixed | 1¼ to 1½ |
| No. 1 white, old, clean | 2¾ to 3 |
| Soiled white: | |
| Street | 1¼ to 1⅓ |
| House | 1½ to 1⅔ |
| No. 2 New Yorks | 1⅛ to 1¼ |
| Street seconds | ⅛ to ⅝ |
| Thirds and blues | 1⅛ to 1¼ |
| No. 1 satinette | 1 to 1¼ |
| Mixed satinette | ½ to ⅔ |
| Tailors' seconds | ⅛ to ¼ |
| Hard black carpets | ½ to ⅝ |

Grades of Rags.—Inspection of the preceding table shows that all rags do not sell for the same price. White rags will bring from 2 to 5 cents per pound more than colored ones, clean rags will sell from ½ to 2 cents per pound more than those that are soiled, and new rags are worth from 1 to 3 cents per pound more than old ones. The paper maker does not cook a mixture of old and new, clean and soiled, white and colored rags together, but wants them properly sorted not only according to color, cleanliness, and amount of wear, but also according to the materials from which the fabrics were made, as cotton, linen, hemp, etc. Unsorted rags, even though they consist largely of the best grades, sell at low prices, and therefore the seller, in order to secure the highest price, should carefully sort them. The higher price of clean rags may even justify washing those that are soiled.

Grades of Waste Paper.—Different kinds of waste paper also sell at different prices, and as mixed paper sells at a comparatively low price, it is profitable to grade it. The following table shows the market grades for waste paper in this country, with current prices of each:

Market Grades for Waste Paper, with Current Prices.

| | Price per 100 pounds. |
|---|---|
| No. 1 hard white | $2.10 to $2.15 |
| No. 2 hard white | 1.80 to 1.90 |
| No. 1 soft white | 1.45 to 1.50 |
| No. 1 colored | .65 to .70 |
| No. 2 colored | $0.45 to $0.55 |
| Flat stock | .75 to .80 |
| Crumpled sheet stock | .70 to .75 |
| Book stock | .55 to .65 |
| Solid ledger stock | 1.40 to 1.50 |
| Ledger stock | 1.20 to 1.25 |
| No. 1 white news | 1.05 to 1.10 |
| White paper | .90 to 1.00 |
| Extra new manila cuttings | 1.25 to 1.30 |
| New manila cuttings | 1.05 to 1.15 |
| No. 1 old manila | .65 to .70 |
| No. 2 old manila | .40 to .45 |
| New box board chips | .35 to .40 |
| New straw chips | .40 to .45 |
| Bogus paper | .50 to .60 |
| Mill wrappers | .50 to .60 |
| Strictly new overissue news | .55 to .65 |
| Strictly folded news | .40 to .45 |
| Broken news | .25 to .30 |
| No. 1 mixed news | .25 to .30 |
| Straight straw and other boxes | .35 to .40 |
| Mixed straw and other boxes | .30 to .35 |
| No. 1 mixed papers | .20 to .35 |
| Common papers | .15 to .20 |

As with rags, new, clean, white materials command higher prices than old, soiled, printed, or colored materials. The kind of fiber of which the paper was made also affects the price, as is shown by the quotation of ledger cuttings as compared with No. 1 book stock, the former as a rule being made of rags, while the latter is largely chemical wood. Therefore in order to secure the highest market price, waste paper should be graded as shown by the table.

Improvements in the Quality of Paper.

One of the most striking points brought out in the work of this laboratory in the examination of paper is that the quality of any class is seldom as good as the materials and the technical skill of the maker can produce. The several processes of paper making frequently are not conducted in such a way as to produce the strongest, most durable, and best appearing papers of a given kind. This is particularly true of papers which should have strength or durability, many of which are overloaded with clay, which weakens them, or are not properly beaten and run to give them good formation and the maximum strength of the material. This is found especially in wrapping papers and boards whose value for practical purposes depends on their strength and pliability. Thus 24 by 36 inch paper, weighing 65 pounds per ream of 500 sheets and made from chemical wood fiber, should easily have a strength of 45 pounds (Mullen), and, indeed, by proper manipulation of the processes such a paper can be made with a strength of 50 pounds. As a matter of fact, however, most 100-pound papers have a strength of only 45 pounds or less per square inch, a result due to the use of ground wood or to insufficient preparation of the stock. Again, in the case of ordinary print paper, well made from chemical wood, a 24 by 36 inch paper, weighing 39 pounds per ream, and having a strength varying from 15 to 20 pounds, is more resistant to folding, as opaque, as strong, and as desirable in every way as many 60-pound papers. Often other desirable qualities are sacrificed to secure temporary appearance and "feel," while the strength is obtained by increasing weight, instead of by a better preparation of stock, as should be the case.

Reduction of Weight and Bulk of Papers.

All classes of paper now made are almost invariably needlessly heavy and thick. The purpose for which paper is employed, whether it be for printing, writing, or wrapping, can be as well accomplished in nearly all cases, both from the utilitarian and the æsthetic point of view, by lighter and thinner paper, as suggested in the preceding section, if greater care in manufacturing is taken. The strength and quality are improved at the same time, and the consumption of paper reduced thereby from 15 to 50 per cent, to the advantage and profit of the consumer. Thus the employment of 60- and 80-pound book papers, or even of 50-pound paper, is a totally unjustified waste in most cases, as every purpose can be accomplished by 30- and 40-pound papers. Much lighter and thinner writing and wrapping papers can be employed in the vast majority of cases with quite as satisfactory results as are obtained from papers that weigh 80, 100, and 120 pounds per ream.

* A circular issued by the Bureau of Chemistry of the Department of Agriculture.

The production of lighter and thinner paper is important not only to the nation, but to the individual as well, since not only are materials thus conserved but better, and frequently cheaper, papers are secured. For example, ordinary printing paper weighs from 45 to 80 pounds per ream (24 by 36 inches), but 35- to 50-pound papers are made from the same materials, which are superior in every particular, a saving of from 22 to 40 per cent in weight. Wrapping papers are of all weights, but many 25- or 50-pound papers are stronger than 50- or 100-pound papers, so that often a saving in weight of as much as 50 per cent can be made. It is true that lighter, thinner, and better papers cost more per pound, but a pound contains more sheets. Paper is sold on the basis of weight, but is used on the basis of area, and a ream of each serves the same purpose. For example, the 35-pound paper mentioned above sells at 4.23 cents per pound, while the 45-pound paper sells at 3.7 cents. Therefore a ream of the former costs $1.65; of the latter, $1.77. Again, bogus manila paper made largely of ground wood (low grade) is quoted at 1.75 cents per pound; No. 1 manila (high grade) is quoted at 5.5 cents per pound, and No. 1 sulphite manila (medium) at 4.75 cents per pound. A 100-pound bogus manila has the same strength as a well-made 35-pound No. 1 manila or a 65-pound No. 1 sulphite manila. A ream of each costs, then, $1.75, $1.92, and $2.92, respectively.

The paper of highest quality and price costs but little more per ream than that of the lowest quality and price and much less than the medium grade. Further, the cost of transporting, handling, and storing heavy bulky paper is greater than for the lighter ones. It is therefore believed that not only will raw materials be conserved, but the cost of the total quantity of paper used per year will be less when it is made lighter and of better quality. On the whole it is a conservative statement that the quantity of paper now used in this country can readily be reduced 25 per cent by making from the materials now employed better paper and by using no heavier paper than is required by the service to be performed.

THE NECESSITY FOR GROWING PAPER-MAKING MATERIALS.

It has frequently been suggested that materials be produced for paper making just as any other farm crop is grown, and it is worth while to inquire into the necessity for doing this. Summarizing the foregoing conservative estimates, there are annually produced in the United States agricultural and industrial wastes furnishing raw materials in much greater quantity than can be consumed in paper making for many years to come.

Estimate of Wastes Suitable for Paper Making Produced Annually.

| Material. | Waste. Quantity. | Waste. Value. | Yield of Paper. |
|---|---|---|---|
| | Tons. | Dollars. | Tons. |
| Waste textiles suitable for papers of the highest quality and strength.. | 1,000,000 | $20,000,000 | 800,000 |
| Flax fiber suitable for the best and strongest paper....... .... ..... | 600,000 | 18,000,000 | 480,000 |
| Forest waste from lumber industry suitable for medium and low grade paper.. ...... .. .... | [1]12,000,000 | 60,000,000 | 5,000,000 |
| Waste paper suitable for high quality and lowest quality.... ... | 1,000,000 | 10,000,000 | 900,000 |
| Cereal straws suitable for medium quality paper and boards. ...... | 70,000,000 | 350,000,000 | 28,000,000 |

[1] Cords.

No consideration is given here to the large quantities of marsh and other wild grasses, of bagasse, and corn and cotton stalks, which are also available, but not as desirable technically as those mentioned, nor to the bast fiber of *malbon* and other bast fibers which occur in large quantities. While it is true that not all of the above-mentioned materials could be acquired for paper making, owing, for example, to their greater value to those who produce them for other purposes, it is evident that there is no danger of the immediate exhaustion of such raw materials even on the present basis of production of paper.

The industrial conditions that have made wood the chief raw material will undoubtedly continue to encourage its extensive use for many years, so that the price of wood will largely fix the price of any competing material. Manifestly no comparisons in dollars and cents can be made, and it will probably be sufficient to say for the guidance of those interested in growing paper-making plants that the problem primarily resolves itself into a financial one. On the one hand, one must produce a material which can successfully compete in quality and cost with other available paper-making materials. On the other hand, the crop produced must be as profitable as other farm crops. If paper can not be made from the new crop as cheaply as from other materials, the mills will not buy it; and if it will not yield as large profits as other farm crops, the farmer will not raise it. It is believed that no plant so far suggested will fulfill these conditions at the present time, except as previously suggested for local consumption where transportation greatly increases the cost of paper made from the commonly used materials.

CONCLUSION.

All fibrous vegetable material from whatever source derived can be used for making paper. The utility of a particular material for this purpose is governed chiefly by the cost and value of the finished paper as compared with the product made from other materials.

Without altering quality, the weights of most papers can be reduced from 10 to 20 per cent, and by decreasing weight and improving quality the amount of paper now consumed can be reduced from 10 to 50 per cent, varying with the kind of paper. It is estimated that the quantity of paper now used in this country can be reduced about 25 per cent by improving its quality and reducing its weight. In other words, 2,250,000 tons of paper will do equally well the service now performed by 3,000,000 tons.

The growing demand for paper-making materials may be supplied by the more conservative use of those which long years of practical paper making have demonstrated are well suited to the purpose. When thus used there are ample quantities to meet normal requirements for many years.

Larger quantities of waste textiles and paper should be employed for paper making. It is estimated that 2,000,000 tons of such wastes, worth approximately $30,000,000, can be secured annually in this country. This material would produce 1,700,000 tons of paper. If this were used, the quantity of wood annually used for paper making could be reduced to about 2,000,000 cords per year.

The cheapest known raw material for medium-grade paper which can be obtained in large quantities is wood. It is highly important to practice conservative methods in its use. Therefore, the great quantity of waste from the lumber industry should be utilized for paper making wherever possible. It is probable that such "new" materials are the cheapest available.

There are large quantities of cultivated and wild straws and grasses and of flax fiber available which can be used for paper making. Economic agricultural considerations indicate that the cultivated straws should only be thus employed when the woods and textile and paper wastes can no longer supply the demand or are too costly. Flax fiber, when it can not be put to more important uses, should be employed in paper making.

Finally, when all of these supplies are no longer adequate and when economic conditions are such as to justify such innovations, there are suitable quick-growing materials which may be produced primarily for paper making.

## ARTIFICIAL PLASTIC SUBSTANCES.

THE manufacture of artificial plastic compositions has become an important branch of industry. These compositions include artificial caoutchouc, artificial leathers, celluloid, viscoid, and other derivatives of cellulose, and plastic masses obtained from casein, maisin, gelatine, albumen and various other substances.

Artificial or Imitation Caoutchouc.—Waste scraps of vulcanized India rubber are pulverized and mixed with a solution of calcium sulphide and tar. The mixture is heated from 24 to 60 hours in a closed digester to dissolve out the sulphur added in vulcanizing, and the tar is distilled off at reduced pressure. The mass is then stirred and washed with hot water.

Neilson regenerates vulcanized rubber by treating it with oil of rosin at from 400 to 570 deg. F.

Ducastle and Alexander employ benzine and solution of soda.

Groetz employs aniline, alcohol, bisulphide of carbon, etc., and precipitates the caoutchouc from the solution of amylic alcohol (fusel oil) methyl alcohol (wood alcohol), or acetone.

Imitations of caoutchouc are also made from oils, for example, by treating a drying oil with monohydrated nitric acid and washing the resultant nitro compound, or by combining the oil with sulphur or chloride of sulphur.

Werbeck prepares a paste of gelatine, phosphate of lime, tannin and bituminous oil, and mixes it with olein soap to produce an imitation of caoutchouc.

Lesage uses gelatine coagulated in glycerine and adds a solution of genuine caoutchouc.

Lusenia di Rosa employs gelatine coagulated by tannin and mixed with castor oil, ether, and fulminating cotton. The mixture is then treated with carbon dioxide or acetylene, and finally evaporated.

Artificial or Imitation Leathers.—Planz makes a substitute for leather by combining jute, cotton, hair, glue, ceresine, lard, and water.

Brigalant treats leather scraps with an alkaline solution, washes them with water and disintegrates them by passing between corrugated rollers. The shreds are then mixed with water and the resultant pulp is refined and converted into sheets by the methods employed in paper-making. The sheets are then piled together and felted to produce leather of the desired thickness.

Sylvestre treats felt with a solution of gum resins, caoutchouc, and oil.

Viscose, combined with cellulose, has been employed in the manufacture of artificial leather.

## PRODUCTION OF HELIUM FROM URANIUM.

By FREDERICK SODDY.

IN a paper in the October number of the Philosophical Magazine of last year I gave a preliminary account of some attempts to detect and measure the production of helium from the primary radio-elements, on which I have been engaged since 1905. The results given were few, and referred mainly to the element thorium. The following further results, obtained since the publication of the paper, with the element uranium carry the subject a stage further. The method is described in detail in the paper referred to. By special arrangements the solutions of the substances employed can be freed absolutely from air, and maintained in this condition indefinitely. After any desired period of accumulation the gases can be completely expelled by boiling the solution in a stream of gas from a voltameter. The expelled gases are freed from water by cooling, and then subjected to the action of the vapor of calcium in a special vacuum furnace, whereby all but the inert gases are perfectly absorbed. After cooling the furnace is filled with mercury, and the residual gas, if any, compressed into the smallest possible spectrum tube of lead glass. The minimum quantity of helium detectable in a successful experiment has been found by repeated trial to be $2 \times 10^{-10}$ gramme. Blank tests with a similar apparatus containing sodium sulphate solution were performed, and I feel confident that the data obtained are trustworthy.

I have used two separate quantities of uranium nitrate. The first and smaller had been carefully purified by Mr. T. D. Mackenzie by extraction with ether. It contained 340 grammes of the element uranium. When it became evident that the rate of production was too slow to be conveniently estimated with this quantity, a second experiment on a much larger scale was started. The cost of this and similar other large-scale experiments was defrayed by a research grant from the Carnegie trustees. Four kilogrammes of uranium nitrate of good commercial quality, which had been re-crystallized from water, were employed. It contained 1,850 grammes of uranium. The preparation of the experiment and complete removal of air were effected by August 15 of this year. The first test for helium was performed after a period of sixty-one days. Helium in several times the minimum quantity detectable by the method employed was proved to be present in the extracted gases. The second test was performed after a period of twenty-seven days. Helium was again present, this time in quantity not much, if any, greater than the minimum detectable. The next test was performed after twelve days. No helium could be detected, although the experiment was a singularly perfect one. An experiment was then performed with the smaller quantity of uranium after a period of accumulation of 128 days. Helium was clearly detected, and its quantity estimated to be not greater than 1.5 times the minimum quantity.

The production of helium from uranium may therefore be considered to be established. With regard to the rate of production, the experiments show that this cannot be far from $2 \times 10^{-12}$ (year)$^{-1}$. That is to say, about 2 milligrammes of helium are formed per year per million kilogrammes of uranium. The second test referred to shows that the rate is not less than 1.5. The third test shows that it is less than 3.3. The last test with the smaller quantity shows that the rate is not less than 1.7, and probably not greater than 2.5. It is of interest to note that the theoretical rate of production I recently calculated from the disintegration theory is $2 \times 10^{-12}$ (year)$^{-1}$, on the assumption that one atom of uranium produced but one atom of helium. These measurements, therefore, lend no support to the view, discussed in the paper referred to, that uranium on disintegration expels two helium atoms.

I may mention that I have commenced the observation of a quantity of sylvine (potassium chloride), one of the minerals investigated by Strutt, and regarded by him as exceptional in containing helium which cannot be ascribed to known radio-active changes. The tests so far indicate that the rate of production of helium from this substance, if any, is below $2.5 \times 10^{-13}$ (year)$^{-1}$.—Nature.

**Freezing Salt.**—Freezing salt, for the production of refrigerating mixtures, contains 20 per cent of calcium chloride, 20 per cent of magnesium chloride, 6 per cent of sodium chloride, 13 per cent of potassium chloride, and 41 per cent of water. If this salt is mixed with an equal volume of snow at 32 deg. F. we obtain a mixture of +5 deg. F. to —4 deg. F. (the latter below zero); if mixed, in equal parts, with snow or crushed ice at 23 deg. F., the temperature of the mixture will sink below —22 deg. F. (below zero).

# THE FIRST PARIS AERONAUTICAL SALON.

## AN INTERESTING COLLECTION OF NOVELTIES.

ON Thursday, December 24, the President of the French Republic opened the second half of the Annual Automobile Salon at the Grand Palais, and incidentally inaugurated the first real exhibition of practical flying machines that has ever been held anywhere. This was the first occasion on which the industrial and pleasure car sections had been arranged consecutively, for hitherto they had been run concurrently in separate buildings. The executive, however, considered that the changed conditions warranted, if they did not compel, a departure from precedent, and hence the arrangement by which the science of flight found room for expression among industrial vehicles and motor boats.

It was for this latter reason, too, that the "*deuxième serie*" of the 1908 Paris Salon had an importance which hardly attached to the pleasure car show, and which was certainly not accorded by the majority of the visitors to the industrial vehicles on view. The flying machines were, without a shadow of doubt, the main attraction for everyone; but whether this had happened to be the case or not, the fact would still remain that they were sufficiently in evidence to justify the use of the significant title, "First Aeronautical Salon." It was an event sure to be of historic interest in the future—even in the very near future, if the progress of flight continues as rapidly as it is doing at present—and as such it must form a basis of comparison for all time.

Those visitors to the Grand Palais who, going specially to see the aeronautical exhibits, entered for the first time by the main doors, must have been disappointed, even if they were not surprised—for no one quite knew beforehand how the show was going to turn out—to find themselves entirely surrounded by heavy machinery and industrial motor vehicles. At first glance, flying machines and all other *appareils d'aviation* were apparently absent, and it was not until the Grande Nef has been traversed toward the Cupole d'Antin that the Aviation Section was reached. True, there was the "Ville de Bordeaux" airship suspended aloft above this very aisle, but it was so big that its long yellow envelope was not at first observed, although the two iron staircases which led up to its car caused a sufficiently obvious obstruction in the gangway. Further down the Grande Nef, too, was a spherical balloon also hung from the lofty roof by wires, and it, being in the immediate perspective, was the more noticeable of the two.

It was, however, around the Grand Staircase and beneath the Cupole d'Antin that those interested in flight congregated. Placed on a pedestal, in a position of honor, a fearful and wonderful bird-like structure stretched its uncanny wings in silent benediction over all who entered; it was Ader's "Avion" (No. 3) which was thus so appropriately placed to form at once a portal to the present and a link with the past. Looking down from the superior elevation of the staircase—and, therefore, in an equally appropriate place—was the full-sized Voisin aeroplane known as "Farman I." Messrs. Voisin, as designers and constructors of some of the leading French machines, deserve a degree of credit for their work,

FRONT VIEW OF ADER'S "AVION NO. 3."

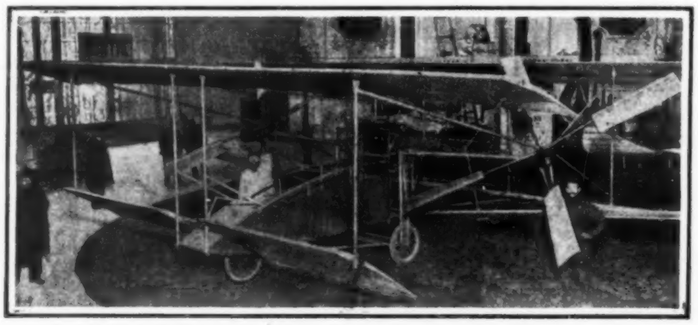
The bird-like appearance of the machine is well shown, as also are the curious feather propellers.

THE FIRST PARIS AERONAUTICAL SALON.

which is far higher than the uninitiated are apt to accord them, although their name must of course always stand second to those intrepid pioneers who have actually practised the art of flight.

Among other full-sized machines were the Delagrange and the Bleriot biplanes—the latter a 3-seater—the Bleriot, R. E. P., and Antoinette monoplanes, Kapferer's double monoplane, and the Breguet aeroplane-helicopter. The Wright aeroplane was represented by a full-sized model, but the others above mentioned were actual machines, and they formed a collection which was, it will be seen, quite as representative as could be expected under the circumstances, and remarkably interesting to boot.

It was a distinct pity that the official catalogue should have contained no list of these and other exhibits, and in view of the importance which may at



GENERAL VIEW OF THE BREGUET HELICOPTER-AEROPLANE.

The large inclined screws are visible in this illustration, as also is the transverse arrangement of the engine. A machine resembling this flew about 60 feet last fall.

any time be associated with such a record, we shall endeavor to remedy the defect as far as possible by compiling a summary. Incidentally, it is interesting simply as a curiosity to reproduce the actual contents of the official catalogue so far as they apply to the present subject. Thus the two lines in the catalogue:

XXI. Aerostation et Aviation.
Grande Nef.

The public at large, however, was in no way deterred by any lack of official guidance in its ferreting out of the novelties, and during the afternoons and evenings the crowd around the different stands was simply enormous. Adding to the numbers, came parties of schoolboys; and on one occasion we observed a large band of Esperantists in charge of a guide who explained the different exhibits in the international tongue. At the stand where the Wright machine was exhibited they met with a particularly hearty reception from one of the directors, who himself addressed them in Esperanto. So popular was the exhibition right from the very first that the Administration was solicited to extend its duration.

We have endeavored in what follows to give as complete an account as possible of the exhibits in a form convenient for reference now and in the future, but in some cases full particulars have not been available. At the present time flight is only just commencing its career as an industry, and there is in consequence a somewhat similar difficulty in obtaining desired information that there used to be in the early days of the motoring industry, when we were on more than one occasion threatened with the police for our all too-persistent curiosity. The public at large was rigorously excluded from the stands.

Although these are the earliest of days, it is impossible to ignore the fact that the flying industry is already born. It is one of those half-hidden aspects of the present situation which makes itself unobtrusively apparent at the Salon, but which might have remained unrealized for a much longer period to come had such an occasion not offered an opportunity for bringing it to light. It is a little apt to be forgotten that the more prominently successful experimenters have been at work for a long time; it must seem an almost incredibly long time to those who have hardly given a thought to the subject before the latter part of the year that has just terminated. One has only to turn back through the pages of this journal to appreciate how far even the publicly known efforts in aviation extend; and, as everyone knows, there is always a vast amount of secret labor in pioneer work which never comes to light until long afterward.

The history of the Wrights is, happily, already fairly complete, and serves as an undying example of *labor omnia vincit* applied to flight. Who would have guessed, however, that it was six years ago that M. Esnault-Pelterie first commenced the work which he has since continued without interruption to the present day? His case is the more interesting since he has not confined himself to any one department; he has built aeroplanes, designed and constructed a very successful engine, and laid down an aviation factory which has now been working for a year and is at present probably the largest in existence. And yet he is one of the youngest of those in the field; in fact, M. Pelterie is a "flying engineer" pure and simple, for he commenced his practical career as soon as he had left his regiment—which he joined directly after taking his degree in science—and he has not, like so many others, graduated in an allied industry. We have cited M. Pelterie as an example not only because it is undoubtedly one of exceptional interest, but because it so aptly points the moral of "going slow" at first in a new thing. As M. Pelterie himself remarked to us at the Salon, "Everywhere today I hear the same expressions of surprise and wonder at what is on view, followed by optimistic conclusions of further wonders to come *immediately*. I am afraid they are going to go too fast; they forget our past laborious work."

It is not alone in the fashioning of complete aeroplanes, and in the designing of light engines, that the present Salon has developed an industrial aeronautic side. There is an even stronger proof of our contention that the industry is born, in the fact that there have already sprung into existence some firms who are devoting special attention to the making of parts. Propellers, frames, radiators, and surface materials are among the *pieces detachés* appertaining to flight, and several most interesting and clever inventions have already found practical expression.

Many visitors doubtless expected to find the greater part of the Salon constituted by models, but such was not at all the case. Models there were in plenty, but we can say without prejudice that in general they did not improve upon the standard of the Agricultural Hall exhibits, either as regards ingenuity or workmanship. A few were designed directly at variance to those main principles on which present day "experts" are fairly well agreed—such as, for example, a model of a machine in which the narrow planes were placed longitudinally—but the majority were nothing but crude conceptions of the modern machines with an additional plane here or there as their sole claim to originality. The flapping-wing machine is in evidence as usual, and it is apparently going to be the pet freak of the Flying Salons of the future. Most of the exhibitors in this section had a seedy and dejected air, and they were too obviously waiting for some ignorant but kind-hearted philanthropist to place a small sum at their disposal for the development of their ideas; we imagine that the smallest of donations would be acceptable in most cases. After giving a more detailed description of the individual exhibits, we have added a short article on the more general subject of aeroplane construction and design

as it was represented by the collection of machines at the Grand Palais. Interesting at any time, such a comparison is all the more important now, since this is the first time in history that it has been possible.

ADER'S AVIONS.

In the electrical world, the name of M. Ader is one of renown for his valuable work in connection with telephones; in the new realm of flight he has an almost equal claim to respect, for he was an early pioneer who not only diligently labored to attain the conquest of the air, but actually achieved some measure of success. It is on record that he flew a distance of 50 meters (164.04 feet) on October 9, 1890, in the grounds of the Chateau d'Armainvilliers, and subsequently, on October 14, 1897, he flew a distance of 300 meters (984.25 feet) at Satory before a committee of army officers delegated by the French government to witness the trial.

The machine was undoubtedly in the air—as shown by the absence of wheel tracks in the wet ground—while it traveled this latter distance, but its direction of flight was, owing to a strong cross-wind, far from the circular course marked out, and this fact, coupled with the damage done to the machine in landing, doubtless led the principal officials to take a gloomy view of its prospects. At any rate, the government refused to continue its financial assistance to the inventor, and M. Ader had reluctantly to abandon his favorite work.

The histories of many pioneers are sad, especially if they are before their time—and Ader was certainly that. Being a Frenchman, he was born in a sympathetic land, however, but even so, he was very fortunate to get so far as to gain the assistance of the government at such an early stage in the proceedings. M. Ader himself was an enthusiast on flight from boyhood, and was of course, therefore regarded by many as a mere dreamer. That was in the days before he became sufficiently wealthy as an electrical engineer to put some of his ideas into practice. To modern eyes, his attempts seemed doomed to failure, it is true, but he did his best with the materials at his disposal, and his name unquestionably deserves to go down to history among those of the great. And, although he himself is now perhaps past taking an active interest in modern work, his engineer, M. Espinosa, is actively engaged in the industry.

Ader built three flying machines, and it was the last* of these that was taken from the museum of the Arts et Metiers to grace the first Aeronautical Exhibition; the others no longer exist. His first machine he called "l'Eole," and with that he achieved the flight of 50 meters in 1890; the third machine, on view in the Grand Palais, is the "Avion," with which he demonstrated before the French government in 1897.

It is a machine of the monoplane type, constructed to resemble a bird in its general shape. Its wings are deeply cambered and arched, and their surface material is stretched over an elaborate framework, presumably intended as a copy of the natural formation of a bird's wing. The wings have a total spread of 16 meters (52.49 feet), and present an area of 56 square meters (602.77 square feet); they extend on either side of the body, and are so mounted that they can be swung forward or backward slightly in order to shift the center of pressure relatively to the center of gravity when desiring to ascend or descend. Beneath the rear portion of the wings, which extend far back in the center, is a rudder controlled by pedals.

The mechanism, all of which is carried by the main body, consists of a multi-tubular alcohol-fired boiler and two horizontal compound engines. The boiler was rated at 40 horse-power, and, when working at 10 atmospheres (140 pounds per square inch), the steam in the dome was usually about 215 deg. C. The engines are placed in front with their cylinders horizontal and their crank-shafts longitudinal. Each is coupled direct to the shaft of a tractor screw. They are compound engines with two high-pressure and two low-pressure cylinders each, the dimensions being 65 and 100 millimeters (2.55 and 3.93 inches) bore by 100 millimeters stroke. At the normal boiler pressure they developed 20 horse-power each at a speed of 600 R. P. M.; their weight is 21 kilogrammes (46.29 pounds) each.

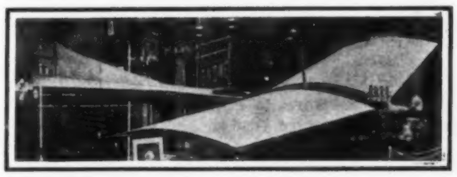
The propellers are most peculiar, for they resemble nothing so much as eight gigantic quill pens arranged in two sets of four. The blades are, in fact, imitation feathers, and are made of bamboo. Each propeller is three meters in diameter, and has a pitch approximating to three meters (it is impossible to give an exact figure with such a form of construction). Their position is such, too, that they overlap one another considerably, and it appears as if that on the port side must have been working under difficulties.

Quite the most interesting fact about the "Avion" is that its entire weight was only 253 kilogrammes (568.79 pounds). This is due to the use of nothing but wood in the construction of the framework, and a system of making the joints and employing hollow struts and beams was thought out by M. Ader for the purpose; it is the same as is now put into practice by the Soc. Cons. d'Appareils Aeriens, of which M. Espinosa (M. Ader's engineer) is a director.

"VILLE DE BORDEAUX" AIRSHIP.

An airship built by Soc. Surcouf for military work, but if not accepted by the army, to go to the Soc. Aerienne, who purpose using it for pleasure-trip service. It is one of the noteworthy series, "La Ville de Paris," "Clement-Bayard," "Col. Renard," and "La Ville de Nancy."

The gas-vessel, which is made of "Continental" fabric, is 53 meters (173.88 feet) long and 15 meters (49.21 feet) in diameter; it holds 3,000 cubic meters (105,943 cubic feet) of gas, and contains an air ballonette which maintains the pressure at 45 millimeters water-gage under all atmospheric conditions. The engine is an 80 horse-power 4-cylinder Renault, and is mounted on four quarter-elliptic leaf-springs placed transversely and shackled to the car. The propeller is 5 meters (16.4 feet) in diameter, and 3.6 meters (11.81 feet) in pitch; it runs at 360 R. P. M., being geared down from the main shaft. In front of the car is a triplane elevator having a surface of 16 square meters (172.22 square feet), and behind is a double rudder for steering. Stability against pitching and rolling is provided for by a group of four pear-shaped gas-bags surrounding the rear end of the main envelope.



THE GASTAMBIDE-MANGIN, OR ANTOINETTE, MONOPLANE.

The car itself was made by Messrs. Esnault-Pelterie, and is mainly of tubular steel work; it is 28 meters (91.86 feet) long. The envelope is made of "Continental" yellow fabric, and its maximum diameter is well forward; there is, however, not much difference in the diameter along most of the center part of the envelope. In front it terminates in a short sharp cone, and behind, in a longer cone with a hemispherical end. To serve as an attachment for the car cords, a strip of wood-cored canvas is sewn to the envelope. The cords are lashed to this, and the car is hung from the cords by steel wires.—Automotor Journal.

## AEROPLANE DESIGN AND CONSTRUCTION.

TYPES OF AEROPLANES.

MONOPLANES have a distinct superiority in numbers over the biplanes at the first Aeronautical Salon, but presumably it is only a matter of individual preference at the present time as to which of the two types has been adopted. The monoplane has, of course, less surface than a biplane occupying the same width of spread, and is therefore a higher speed machine. It lends itself to simplicity of construction, and if fitted with a tractor screw, as most are, to the use of a direct-coupled engine. The absence of transmission chains is, of course, a merit in itself, but the direct drive involves a high-speed propeller, which appears to be attended with other complications. On a monoplane, the size and pitch of a screw of reasonable size appears to render high speed necessary in order to give the velocity required for flight, so to this extent the conditions are in common accord. On the Pischoff monoplane there are two chain-driven propellers placed behind the main wings, as on most biplanes.

Having thus briefly dealt with the types in general, we give below a table summarizing the various aeroplanes on view. Among the details included in this list are certain leading dimensions, and also the weight of the different machines in flying order but without the pilot; these latter figures, however, are not such as should be regarded as too literally exact, if the comparative appearances of the aeroplanes themselves may be taken as any guide.

| Machine. | Exhibitor. | Details. | | | |
|---|---|---|---|---|---|
| | | Spread. | Surface. | Weight. | Engine. |
| **Monoplanes.** | | | | | |
| | | m. | sq. m. | kgs. | h.p. |
| Ader's Avion (No. 3) | Arts et Metiers Museum | 16 | 56 | 258 | 40 steam |
| R. E. P. (No. 2 bis) | Etab. R. E. Pelterie ... | 9·6 | 15·7 | 360 | 35 7-cyl. R. E. P. |
| Bleriot (No. 9) ... | Soc. Bleriot ... ... | 9 | 24 | 410 | 50 16-cyl. Antoinette |
| Bleriot (No. 11) ... | Soc. Bleriot ... ... | 7 | 13 | 160 | 35 7-cyl. R. E. P. |
| Antoinette ... ... | Soc. Antoinette ... | 12. | 40 | 500 | 50 8-cyl. Antoinette |
| La Demoiselle ... | Santos Dumont ... | — | 9 | 67 | 2-cyl. |
| Pischoff ... ... | Pischoff and Koechlin | — | 23 | — | 17 2-cyl. |
| Vendome (No. 2) ... | R. Vendome .. ... | 9 | 26 | 305 | 50 3-cyl. Anzani |
| Clement-Bayard ... | Clement-Bayard ... | 12·5 | 23 | 400 | 50 7-cyl. B.-C. |
| **Double Monoplanes.** | | | | | |
| Astra (Kapferer) ... | Soc. Surcouf ... ... | 10 | 40 | — | 35 7-cyl. R. E. P. |
| **Biplanes.** | | | | | |
| Wright (model) ... | Cie. Navigation Aérienne | 12·5 | — | 450 | 22 4-cyl. B.M. |
| Farman (No. 1) ... | Voisin Frères ... ... | 10·2 | 52 | 500 | 50 8-cyl. Antoinette |
| Delagrange (No. 3) | Soc. d'Encouragement | 10·5 | 40 | 450 | 50 8 cyl. Antoinette |
| Bleriot (No. 10) (3-seater) | Bleriot... ... .. | 13 | 65 | 480 | 50 8-cyl. Antoinette |
| Lejune (No. 1) ... | Lejune... ... ... | 6·5 | 23 | 150 | 12 3-cyl. Buchet |
| **Special.** | | | | | |
| Breguet helicopter-aeroplane | Breguet ... ... | 14 | 60 | 550 | 50 8-cyl. Antoinette |

INSTALLATION.

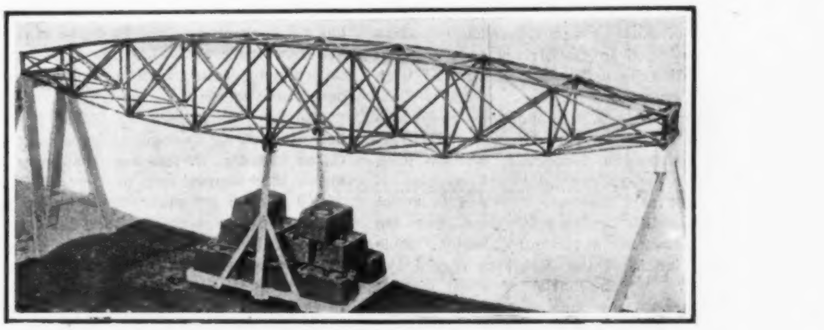
The tractor screw in front, as representing a principle of propulsion, is one to which Sir Hiram Maxim, in his recent book, is strongly opposed, on the ground that it fails to take advantage of the air set in motion by the machine as a whole as a means of neutralizing some of the normal slip. On the other hand, M. Esnault-Pelterie, among others, considers that the wake from the slip itself is turned to better account with tractor screw because it creates a higher effective velocity of the air under the center of the main wings. The Pelterie monoplane, however, is constructed to make as much use of this central air current as possible, but there are others which are not, and at the best, the frame, whatever its shape, occupies a considerable cross-section behind the screw. At the moment, therefore, it may be said that the engines are usually placed in front of monoplanes because that position makes the best mechanical job of the installation.

On biplanes the engine is either on one side of the pilot, as on the Wright and Bleriot machines, or immediately behind, as on the Farman and Delagrange (Voisin) aeroplanes. In all cases the propellers are just behind the main planes, and on the Wright, where there are two, and on the Bleriot, where there is only one, they are driven by chains. The Voisin machines have a direct drive. When there are two propellers they should turn in opposite directions in order to neutralize the tilting effect, and on the Wright machine this is accomplished by crossing one of the chains. The chains are inclosed in tubes, and as the motor is alongside the pilot one chain is longer than the other; it is this one which is crossed.

FRAMES.

Wood is the favorite material at the present time for the framework of aeroplanes, and, indeed, it seems likely to give birth to quite a new development of constructive engineering.

Already two firms have specialized in the manufacture of hollow wood beams and struts, and one in particular—the Soc. Anon. Construction d'Appareils Aériens—exhibit some most interesting models of elliptic lattice girders showing great refinement of workmanship. Wood, as is well known, is ordinarily



VIEW OF THE CENTRAL BODY FRAME OF AN AEROPLANE MADE OF WOOD BY THE SOCIÉTÉ CONSTRUCTION D'APPAREILS AERIENS.

This structure, 5 meters (16.4 feet) in length and weighing only 6 kilogrammes (13¼ pounds), is shown supporting a weight of 400 kilogrammes (881.84 pounds).

THE FIRST PARIS AERONAUTICAL SALON.

* A complete illustrated description of this machine was published in SUPPLEMENT No 1613.

lighter than metal for the same strength, although it is much more bulky.

On an aeroplane the bulk of wood required is not disproportionate to the present size of the machine—whatever it may be in the future—and in consequence it has become a very popular material. Only two notable examples of steel need be referred to, the Breguet and the R. E. P. In the latter case the frame is comparatively small, and in the former it is very extensive, and, in fact, forms an interesting example of tubular steel work quite apart from any reference to its application to the subject under discussion.

Most of the monoplanes have boat-like frames of V section, which gives some of them the appearance of racing skiffs; in a few cases, the sides are actually wood-covered, at any rate in part, but in general the frame is a light skeleton structure covered with fabric. In general, such frames taper in section aft, and either have a bluff end forward or a short sharp point. A feature of the Wright frame is the detachability of the struts between the two main planes; the ends of the struts are fitted with steel screw-eyes, which fasten on to corresponding curled hooks. Diagonal wire stays give the necessary stiffness in conjunction with the runners, which form a base for the machine as well as a support for the elevator in front.

SURFACE MATERIALS

Fabric, made of Egyptian cotton treated with rubber, constructed by the Continental Tyre Company, is a popular surface material for covering the wings of aeroplanes, as it is readily obtainable in any weight and strength, and is impervious to rain. Some of the machines, however, use other things, as, for instance, the Bleriot No. 9, which has a vellum-like paper covering; the Bayard-Clement, which employs varnished silk; and the Antoinette, which uses varnished linen. This latter is hand polished to give great smoothness, and has a fine glossy finish; so, too, has the silk of the Bayard-Clement monoplane, but the fabrics are not usually prepared with a specially smooth surface.

SYSTEMS OF CONTROL.

There is no more interesting feature of the aeroplane, nor one in which greater difference in detail finds expression in practice, than the system of control. Especially is this the case in connection with the steering and elevating levers themselves, all kinds of devices having been adopted by the different inventors as being most in accord with their own individual ideas on the subject. So far as the actual means of maneuvering the machine are concerned, the difference is naturally less marked, for most of them have well-defined rudders and elevators.

In the monoplane type of machine there is greater variety in the details of control than with the biplanes, the differences in the latter class being mainly concerned with the placing of the rudder aft and elevator forward, or vice versa. On the monoplanes, however, the main wings themselves are generally brought into play in one way or another, either by total flexion or warping as on the R. E. P. and Vendôme aeroplanes, or by the use of steering tips as on the Bleriot No. 9 and Antoinette. In the R. E. P. monoplane the warping of the wings in opposite directions simultaneously serves for all ordinary maneuvering without resorting to the rudder, which is under the control of a separate lever. Rising and falling is accomplished by tilting the elevator by a to-and-fro motion of the same pivoted lever which warps the wings. On the Vendôme monoplane each wing is warped by a separate lever, and as these levers are very massive and pronounced, standing out well above the frame, the pilot must assume somewhat the same attitude as is presented by the driver of a traction engine, who is ordinarily seen wending his way with each hand firmly grasping a handle.

Although, as in the R. E. P. monoplane, the warping of the wings is used for the purpose of steering, it is necessary to draw a distinction between such arrangements and the rudder pure and simple, because for the most part they are provided to assist in maintaining stability, quite apart from any use which they may have for governing direction. It is in this capacity, too, that the designers regard the use of steering-tips, which consist of small pivoted extremities attached to the ends of the main wings. Being at a great distance from the center of the machine, they have a considerable leverage, and, operating as they do upon both sides of the center simultaneously, the rapidity with which they are able to produce an effect is enhanced. It is, therefore, upon this device that the pilot mostly relies to keep his equilibrium. The warping of the main planes is, as our readers know, one of the great features of the Wright aeroplane; but in the machine exhibited, the movement is accompanied by a turning of the rudder; the elevator on the Wright aeroplane is under the control of a separate lever.

As to the levers themselves, custom differs widely, as we have already mentioned. Wright (on the machine exhibited) uses two simple rods, one hinged to rock laterally for steering, the other to move to and fro for rising and falling. In the Farman, Delagrange, and Kapferer aeroplanes, the pilot clutches a steering wheel similar to that used on a motor car, but placed in a vertical plane; for steering, it is turned as on a boat, while for varying the altitude of flight it is pulled or pushed bodily to and fro. Such a system as this, it will be observed, allows either or both hands to do all the work that is required. On the R. E. P. and Breguet machines the system of single-lever control has been restricted to the pilot's left hand, the lever in question on the R. E. P. monoplane being pivoted universally to move in any direction; while the Breguet system is to fit the elevating lever with a rotary handle which is twisted for the purpose of steering.

In the following tabular summary, brief particulars, so far as they are available, are given of the methods of control adopted on the various aeroplanes exhibited:

One-Hand Control.

"Bleriot No. 9."—Pivoted lever, fitted with steering-wheel handle. Moves to and fro to ascend (elevator), and sideways to turn (rudder and steering tips).

"Voisin" (Delagrange and Farman).—Vertical steering-wheel. Rotates to turn (rudder), and is pulled or pushed to go up or down (elevator).

"Astra" (Kapferer).—Same as "Voisin."

"R. E. P."—Three levers. One moves to and fro to ascend (elevator), sideways for stability and to steer (warp wings); one sets rudder; and the third works the elevator or horizontal rudder.

Hand and Foot Control.

"Bleriot No. 10."—Pivoted lever fitted with steering-wheel handle. To and fro to ascend (elevators), sideways for stability and to turn (elevators); foot rudder.

"Bleriot No. 11."—Pivoted lever as on No. 10. To and fro to ascend (elevators); sideways for stability and to turn (warp wings); foot rudder.

"Breguet."—Hinged lever with pivoted handle. To and fro to ascend (elevator), rotate handle to turn (rudder), foot operates extra steering planes.

"Vendome."—Three levers and two pedals all separate. Two levers to warp wings, separately or together (steering or ascending); one lever to set tail (long ascents); two pedals to work steering tips separately (sharp turning).

Two-Hand Control.

"Antoinette."—Rudder operated by ropes; steering tips by another rope; elevator by a wheel at the pilot's side.

"Clement."—One lever and one wheel; lever for elevator, wheel for rudder.

"Wright."—Two levers; one for elevator, one for rudder and warping wings.—Automotor Journal.

## THE DESIGN OF CYLINDERS FOR THE STORAGE OF CARBONIC ACID.*

By REID T. STEWART, M.Am.Soc.M.E.

CARBONIC acid as commercially handled may exist in three distinctly different states—the gaseous, the vaporous, and the liquid.

Commercial carbonic acid is manufactured, collected as a by-product or from natural sources, as either a gas or a superheated vapor. After being compressed and cooled sufficiently, this gas or vapor is converted into a liquid, which is charged into steel cylinders for transportation to the consumer.

From the standpoint of the physicist the critical temperature is that temperature above which a substance always exists in the gaseous state, for at temperatures above the critical temperature no substance has yet been reduced to the liquid state by any pressure, however great; while for temperatures below the critical temperature all the commonly occurring gases have been liquefied.

The critical temperature of purified and dried carbon dioxide, as determined by Amagat, is 31.35 deg. C., or 88.4 deg. F. He has compressed the gas while above this temperature to a pressure approximating 15,000 pounds per square inch, and thus to a density about 10 per cent greater than that of water, without reducing it to a liquid. For any temperature below this critical temperature he found a definite and fixed pressure at which the carbon dioxide could be reduced to the liquid state (e. g., 504 pounds per square inch at 32 deg. F.; 744 pounds at 60 deg. F.; and 1,071 pounds at 88.4 deg. F., or the critical temperature).

An investigation of the relative merits of the different formulas that have been published for the strength of tubes which are subjected to internal fluid pressures, has led the author to the belief that Claverino's formula is the most reliable, when the tube wall is subjected to both the transverse and longitudinal stresses due to the internal fluid pressure; as is the case in a carbonic acid cylinder.

The author has produced an exceedingly close approximation to Claverino's formula for values of $t/D$ less than 0.1, which fully covers the range in values of $t/D$ for the conditions of minimum weight of cylinder per unit weight of contained carbonic acid. This very close approximate formula for steel carbonic acid cylinder conditions, gives the relations: $D/t = 2.325\,f/p$, or $t/D = 0.43\,p/f$; where $D$ = outside diameter of cylinder in inches, $t$ = thickness of cylinder wall in inches, $f$ = fiber stress in wall of cylinder in pounds per square inch, and $p$ = internal fluid pressure in pounds per square inch.

Table I.—Thickness and Charging Factors for Carbonic Acid Cylinders for Minimum Weight of Steel in Shell per Unit Weight of Acid Contained.

| Fiber Stress in Wall, Lbs. per Sq. Inch. | Factors for Thickness of Wall (t/D) Greatest Temperature Change in Cylinder. | | | | | |
|---|---|---|---|---|---|---|
| | 100° F. | 110° F. | 120° F. | 130° F. | 140° F. | 150° F. |
| 15,000 | .0398 | .0452 | .0499 | .0542 | .0581 | .0616 |
| 16,000 | .0375 | .0425 | .0470 | .0511 | .0547 | .0581 |
| 18,000 | .0334 | .0379 | .0419 | .0455 | .0487 | .0518 |
| 20,000 | .0300 | .0341 | .0377 | .0410 | .0439 | .0468 |
| 24,000 | .0261 | .0285 | .0316 | .0344 | .0370 | .0393 |
| 27,000 | .0223 | .0254 | .0282 | .0307 | .0331 | .0353 |
| 30,000 | .0202 | .0229 | .0254 | .0278 | .0299 | .0320 |
| * Mean density of $CO_2$. | .65 | .63 | .61 | .59 | .57 | .55 |
| * Lbs. $CO_2$ per cu. inch. | .0235 | .0228 | .0220 | .0212 | .0205 | .0198 |
| * Lbs. $CO_2$ per U. S. gal. | 5.42 | 5.27 | 5.07 | 4.90 | 4.73 | 4.57 |

* Substantially correct for fiber stresses from 15,000 to 30,000 lbs. per sq. inch.

Table I. is based upon the results of laboratory experiments on purified and dried carbon dioxide. It is therefore directly applicable to the storage in steel cylinders of chemically pure acid.

Assuming, for instance, the maximum working fiber stress in the wall of a cylinder to be 18,000 pounds per square inch, and the maximum storage temperature of the carbonic acid to be 120 deg. F., we find from Table I. the corresponding thickness factor, $t/D$ to be 0.0419. For these conditions, then, a cylinder of 6 inches outside diameter should have a thickness $t$, equal to $0.0419 \times 6$, or 0.2514 inch, which is approximately ¼ inch.

For calculating the fiber stress in the wall of a carbonic acid cylinder, use the formula given earlier, transposed to read:

$$f = 0.43\,pD/t.$$

This simple formula gives results, which, for carbonic acid cylinder conditions, approximate exceedingly close to those obtained by the use of Claverino's theoretically correct formula, which is

$$f = p\,[4D^2 + (D - 2t)^2]/3\,[D^2 - (D - 2t)^2]$$

Table II.—Pressure Exerted by Carbonic Acid Against Walls of Cylinder in Pounds per Square Inch.

| * Density. | 100° F. | 110° F. | 120° F. | 130° F. | 140° F. |
|---|---|---|---|---|---|
| .55 | 1270 | 1450 | 1630 | 1810 | 1995 |
| .57 | 1290 | 1475 | 1670 | 1860 | 2055 |
| .59 | 1310 | 1505 | 1710 | 1915 | 2125 |
| .61 | 1330 | 1540 | 1760 | 1975 | 2200 |
| .63 | 1355 | 1580 | 1815 | 2045 | 2285 |
| .65 | 1395 | 1630 | 1875 | 2120 | 2375 |
| * Density. | 150° F. | 180° F. | 200° F. | 212° F. | .... |
| .55 | 2180 | 2735 | 3110 | 3340 | .... |
| .57 | 2255 | 2845 | 3245 | 3490 | .... |
| .59 | 2335 | 2970 | 3395 | 3655 | .... |
| .61 | 2425 | 3100 | 3555 | 3835 | .... |
| .63 | 2525 | 3240 | 3725 | 4020 | .... |
| .65 | 2630 | 3395 | 3910 | 4225 | .... |

* Taking water at 39.2° F. as unity.

Table II. gives the absolute fluid pressures of pure carbonic acid gas in pounds per square inch. When the air content is excessive, a correction of about 60 pounds increase in tabular pressure should be made for each per cent of air contained in the carbonic acid, for temperatures ranging from 100 to 140 deg. F.

A cylinder having a water capacity of 33 pounds when charged with 20 pounds of commercial acid, corresponding to a tabular density of 20/33 or 0.61, and having an air content of 2 per cent, when at a temperature of 120 deg. F., will be subjected to a fluid pressure, according to Table II., of $1{,}760 + (60 \times 2)$, or 1,880 pounds per square inch. If now this cylinder have an outside diameter of 6 inches, and a thickness of wall of ¼ inch, then the fiber stress in the wall will be $f = 0.43\,pD/t = 0.43\,(1{,}880 \times 6)/0.25 = 19{,}400$ pounds per square inch.

* From a paper entitled "The Physical Properties of Carbonic Acid and the Conditions of Its Economic Storage for Transportation," presented at the New York meeting of the American Society of Mechanical Engineers.

**The records** for November are not available, but indications are that the net result of the movement of aliens to and from the United States is now in favor of this country. In October there was a net influx of 6,249. In November the departures showed a lessening tendency, while the arrivals increased. The arrivals through all ports in October were 40,994, against 111,513 in October, 1907, and 99,974 and 86,758 for that month in 1906 and 1905 respectively. For the first 10 months of this year the arrivals were 327,240, against 1,150,116 and 1,035,602 for the like periods in 1907 and 1906 respectively.

# OIL ENGINES.*

## THE COMMERCIAL PROGRESS OF A NEW PRIME MOVER.

BY W. A. TOOKEY.

ENGINES served with lighter liquid hydrocarbons as fuel have been very largely adopted for vehicular service. Their application, however, as far as this country is concerned, is confined almost entirely to those cases in which considerations of efficiency and economy are outweighed by other advantages. Some very remarkable endurance tests have been accomplished in the various automobile contests in Great Britain and abroad, and engineers generally deserve not a little credit for the excellent work they have done in securing such results within a comparatively recent period.

Engines served by power gases of greatly varying composition have demonstrated their advantages with such emphasis that to-day every power-user gives careful consideration to their claims when deciding upon the purchase of new motive power. In course of time the majority of industrial processes will be driven by gas power where steam has hitherto been the prime mover. At the present day examples can be seen both in this country and abroad of which the present generation of engineers, as a body, may well feel proud, in view of the fact that the most striking advances have been made within the last few years.

With regard to engines that generate power from the heavier petroleum products, it must be admitted that progress toward perfection has been made at a much slower rate. There is little doubt that the development of other forms of internal combustion engines, and particularly those served by gas producers worked on the "suction" principle, has diverted the interest of engineers and designers from the problems that are still to be solved before the oil engine can claim equal efficiency to the gas engine as a power generator.

But while such a statement is broadly true, one exception has to be specially noted. The Diesel oil engine compares most favorably with the latest type of gas engine with regard to the number of heat units converted into useful work at any given output. Nevertheless, oil engines of other types than the Diesel engine have been sold in increasing numbers year by year until there is, probably, no portion of the civilized world where an example is not to be found. Their widespread application has been due, mainly, to their conveniences. Even so, the relative economy of fuel has been such as to displace the smaller types of steam engine, while the occasional inspection necessary when in operation is of such a nature that a separate attendant—indispensable for stoking steam boilers—is not required.

The commercial progress of the oil engine is an undoubted fact, and, perhaps, it is because of the ready demand that makers have not shown any great degree of success in conducting experiments having for a goal the increase of efficiency which alone marks true progress in engineering science.

The Priestman oil engine of twenty years ago heralded a new era in internal-combustion engines. Then, for the first time, the heavier petroleum products were successfully utilized for power production. The leading features of this engine must be well known to the members of this association, as in the leading technical works upon gas and oil engines full particulars are to be found. At full load the consumption of an engine of this type, tested by Prof. Unwin, amounted to 0.946 pound per brake-horse-power per hour, although the engine was but a small one, with 8.5-inch diameter cylinder and 12-inch stroke, developing 6.76 brake-horse-power at 208 revolutions per minute.

In the latest type of engine as made by a leading firm the full-load consumption is 0.875 pound per brake-horse-power per hour for an engine of similar size. This slight difference is mainly due to the reduction of frictional losses consequent upon simplification of detail parts. It appears that very little progress from a thermal efficiency point of view has been made during the last twenty years.

The comparison of the performances of different types of engines is usually noted by observing the amount of fuel consumed per brake-horse-power per hour as mentioned in the two previous paragraphs, but while this method is convenient it is apt to obscure the true relative merits.

It is possible to show by means of charts how misleading such statements can be when used as the sole indication to the efficiency of internal combustion engines in general and oil engines in particular.

According to the results recorded by well-qualified experimenters during recent years, it is a fact that many oil engines made to-day become more extravagant in fuel consumption as their output of power increases. Yet by the standard of "so much fuel per brake-horse-power per hour" they appear to give more power with less oil the nearer the load approaches the maximum.

A little consideration, however, will show that an engine would have to be very extravagant indeed not to show an apparent decrease upon the "consumption per brake-horse-power per hour" basis.

What, then, are the features common to those engines which enable best results to be achieved, and what are the differences in the method of treatment adopted by other makers which places them so far behind?

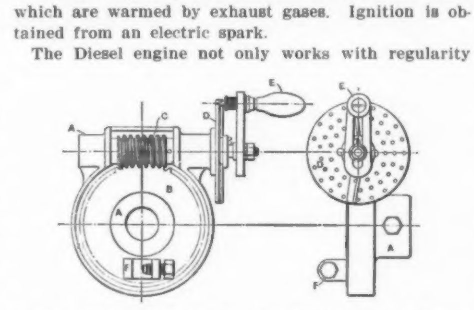
Both the Priestman and the Diesel engine inject the fuel by spraying in combination with air.

Both the Diesel and Priestman engines are governed by varying the intensity of the explosion or duration of combustion, which takes place at every cycle. In both, the quantity of fuel is automatically regulated to accord with the load demand. In the Diesel the compression pressure is uniform. In the Priestman the compression pressure varies.

In the Diesel engine there is no previous vaporization of the oil, as the fuel burns immediately upon its entry into the cylinder.

In the Priestman engine there is vaporization of the oil due to the heat within the cylinder during suction and compression strokes and in the connections which are warmed by exhaust gases. Ignition is obtained from an electric spark.

The Diesel engine not only works with regularity



**A Dividing Head for Milling, Graduating, etc., Between Lathe Centers. It is Mounted on the Tail-stock Spindle.**

of combustion, but the governing is very steady, due to the fact that the quantity of fuel is determined at the very instant that the working stroke commences and not two strokes in advance. The fuel entering with air burns at once and has no time to become diluted with the excess of air present. Thus there can be practically no physical change in the fuel between the moment of its injection and its combustion.

In the Priestman engine and all others of which the performances are represented, very considerable physical change takes place during the period that elapses between entry of the fuel and its combustion.

It can be seen that those engines are more inefficient at light loads when the method of governing adopted is by reducing the amount of mixture admitted, even though the proportions of oil and air may be kept constant as far as is practicable.

During the next few years we may expect a very big forward movement in connection with the oil engine. Engineers generally are giving more attention to its evolution, and the existing low-thermal efficiencies will soon be things of the past. The advantages of the oil engine are becoming more widely known, and for marine purposes especially they are particularly suitable. As time goes on the quantity of liquid fuel is shown to be better distributed throughout the world. Suitable fuel can be extracted from many sources now looked upon as waste, and as soon as engines are to be obtained able to utilize low-grade fuel, the supply of the latter will increase.

For the small farmer and miller, for country house electric lighting, and many similar classes of work, the oil engine has special advantages. It requires occasional cleaning, but otherwise calls for no attention beyond the filling of oil and water reservoirs. It can be started at any time at short notice, and there is no trouble in connection with the raw fuel as is sometimes found with the bulk (and quality) of coal.

Designers generally should bear in mind that while it is comparatively simple to get an engine to run well and give good results on the test bench, it is very difficult to build an engine than can be relied upon to give fair service under all working conditions. Those little things that are always happening of no particular importance when a man who knows how to handle oil engines is in attendance, frequently cause trouble when nobody with the requisite knowledge is within miles.

Cases have occurred within the writer's experience when most disquieting letters have been received from abroad with regard to the working of engines set up in places where no skilled men are available. A great many journeys have to be paid to out-of-the-way places by makers' representatives to find out why an engine is giving trouble when correspondence would be useless and the loss of a good customer possible. Many of such journeys are undertaken to set right a very trivial thing involving perhaps a few minutes' work.

To be successful from a selling agent's point of view an oil engine must have a minimum of complication. It must start readily. It should not require the continuous burning of a lamp, which calls for more or less constant attention and somewhat delicate manipulation. It should not require a number of spare parts of a special nature which cannot be procured locally.

Engines fitted with ignition tubes frequently get into trouble. The stock of spare tubes runs out and others obtained from the nearest depot are often either shorter or longer or of different material, causing the ignition of the engine to be faulty and the engine itself to be condemned. It is no use saying that an engine could not be expected to work well under such circumstances, and that it is the owner's fault. The ideal engine from a commercial standpoint is that which will continue in operation even after a native has tried to wrench off every bolt end by means of a long-handled spanner, and has done his best to break every part with a hammer.

There should be no details exposed to invite zealous attentions from the well-intentioned layman. The refinements of adjustment should be done on the test bench. The engine as it leaves the shop should have the vital settings strikingly marked and, if posible, riveted. There should be on every engine an unmistakable gage point on the bed, against which, as the flywheel is turned, indications on the rim of the wheel could be read off so that the different valve movements could be checked from time to time.

Lamps and ignition tubes undoubtedly give rise to most trouble in practical service. The necessity for cleaning gives many opportunities for these to be damaged or otherwise improperly treated. It would astonish many designers if they could see the number of engines originally supplied with pressure gages on pump pipes now working with wooden plugs. The book of instructions that is so laboriously compiled and marked "to be hung in the engine room for reference" is rarely found in the possession of the attendant, and when it is, the remarks that are often made respecting it are in anything but complimentary terms.

* Read before the Manchester Association of Engineers.

## DIVIDING HEAD FOR USE WITH THE LATHE.

OCCASIONALLY it is necessary to do on the lathe a piece of work that requires dividing. If there is no milling machine in the shop, the lathe is sometimes rigged with a milling spindle on a knee attached to the carriage, for operating on work between centers. If a gear, for instance, is to be cut in this way, the question of indexing is often somewhat puzzling. If the number of teeth desired is a factor of the number of teeth in the main spindle driving gear, this may be used for indexing. If not, other more cumbersome methods have to be devised. The apparatus shown in the accompanying engraving is intended to give the lathe for such work nearly as great facility as is offered by the milling machine with its dividing head. This device, which is patented, was illustrated in a recent issue of Machines Outils et Outillage, of Paris.

The main casting *A*, of the attachment is fastened, by the set-screw shown, to the tail-stock spindle. On the front side it is provided with a projecting hub which forms a journal for dividing worm-wheel *B*. The main casting incloses this wheel in a guard, and on its upper side is provided with bearings to support the shaft on which the worm *C* is mounted. The worm shaft is controlled by the adjustable crank *E*, having a pin entering holes in index plate *D*, substantially as arranged for the milling machine dividing head. The usual adjustable sectors are provided. The work, which is supposed to be mounted on centers, is driven by a dog whose tail is engaged in clamp *F*, bolted to the face of the index wheel *B*. It will readily be seen that any desired spacing can be given to the work thus mounted, by operating the index handle in the same way as in the milling machine.—Machinery.

# THE TRAINING OF DIVERS.

## THE WORK OF THE BRITISH NAVAL SCHOOL.

### BY OUR ENGLISH CORRESPONDENT.

EVERY vessel in the British navy carries a diving section, composed of men expert and skillful in all kinds of submarine work. Such a detachment is absolutely indispensable, in view of the fact that through unforeseen circumstances the submerged portion of the hull of the armorclad, and especially the propellers, often require examination; while in cases of accident, such as collision and running aground, a close investigation to discover any possible injury to the iron sheath of the ship has to be carried out, and occasionally submarine patching has to be done until the vessel can reach drydock.

The diving section of the British navy is comprised throughout of volunteers. No man is compelled to become a member of the detachment, even if physically fit, owing to the peculiarly hazardous and arduous nature of the work. As an inducement, however, the Admiralty pay the divers a higher salary, as well as offering the men other special privileges.

When a man volunteers for diving service, he is at first submitted to a rigorous medical examination. Owing to the enormous pressures to which the body is subjected at different depths, only those with the strongest constitutions and in perfect health are admitted. No man is passed who has a short neck, is full blooded, or has a florid complexion; nor those suffering from head and heart complaints, or from a sluggish circulation of the blood. The medical qualifications are very strict, as indeed they should be, as a weakened constitution would expose the man to extremely dangerous risks under water. Furthermore, when a man passes beneath the water's surface, any physical defects he may possess immediately show themselves in an accentuated manner.

The medical conditions satisfied, the man is drafted to one of the three diving schools. These are at Portsmouth, Devonport, and Chatham, respectively, but the largest and most important is at the premier dockyard of Portsmouth. Here the man is initiated into submarine work, special classes for this purpose being held. As the first and greatest difficulty which the man has to surmount is nervousness, the training is not carried out in the open sea, but in a large circular steel tank built on the shore. This tank measures about 13 feet in height by approximately 18 feet in diameter, and is pierced with a number of glazed portholes, through which the instructor can follow and watch his pupils' movements. A gallery extends around the top of this tank a short distance, from which the diver makes his descents into, and ascents from, the water within.

The man is first instructed in the nature of his dress and equipment, and how to employ the appurtenances with which he is provided, such as the telephone, lifeline, and ladder. Owing to the clumsy and weighty nature of the diving dress, the sailor experiences considerable difficulty in becoming accustomed to it. He is then instructed as to the manner in which he must descend and ascend the ladder, and how to utilize the outfit and tools with which he is supplied. The first named is a most important point.

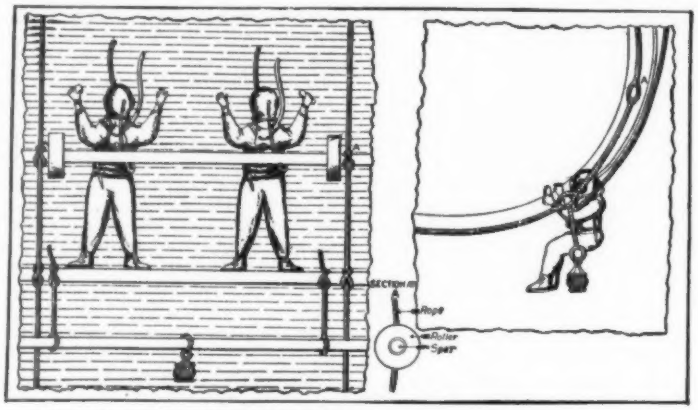
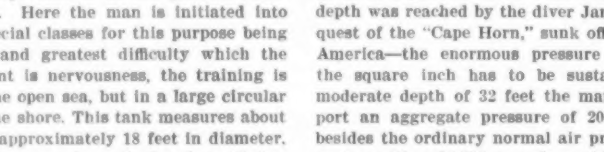


DIAGRAM SHOWING HOW DIVERS WORK ON THE STAGING IN ORDER TO CLEAN THE BOTTOMS OF WARSHIPS.

Directly the diver disappears beneath the surface of the water, his body becomes subjected to a heavier pressure. For instance, at a depth of 20 feet the pressure is 8½ pounds to the square inch above atmospheric. It increases proportionately as he descends lower and lower until at, say, 204 feet, which is the greatest depth to which a diver has penetrated—this depth was reached by the diver James Hooper, when in quest of the "Cape Horn," sunk off Pichidanque, South America—the enormous pressure of 88½ pounds to the square inch has to be sustained. Even at the moderate depth of 32 feet the man's body has to support an aggregate pressure of 20,000 pounds weight, besides the ordinary normal air pressure, which represents another 20,000 pounds, making a total pressure of 40,000 pounds.


THE DIVING TANK AT WHALE ISLAND, WHERE SAILORS ARE TAUGHT HOW TO DIVE.

THE BRITISH NAVAL SCHOOL FOR THE TRAINING OF DIVERS.

When a diver makes his initial descent, owing to the strangeness of the experience, he suffers from a curious pulsation and gasping for breath. These peculiarities will not be overcome until the man has regained his confidence.

Should a man betray evidences of more than usual nervousness after his first descent into the water, he is expelled from the class; for although the Admiralty do not compel a man to become a diver, they insist that he should immediately overcome any inherent timidity. The instructor accompanies the man to the gallery of the tank, conveys to him his commands, especially insisting upon slow ascent and descent. The diver then enters the water, and the instructor follows his movements through the glazed portholes, transmits his instructions through the telephonic apparatus, and inculcates the man into the code of signals generally employed. At first the sailor experiences considerable difficulty in moving about the bottom of the tank in his 40-pound shoes—the total weight of a diver's dress is 160 pounds—but in a short time he becomes accustomed to the task.

The diver undergoes six weeks' training at this curious school. At the conclusion of this term he is attached to the open-sea class, and has to carry out his work under natural conditions.

As the instructor cannot now watch the diver's movements, the pupil has to rely upon his own confidence. Diving in a tank in a limited water space he soon finds to be vastly different from diving in the open sea, where he has to encounter currents and tides.

Before he makes his descent, the instructor impresses again upon the diver the urgent necessity of careful descent and ascent, and what to do if he desires to come to the surface suddenly, or emergency necessitates a rapid ascent. These instructions are most vital, especially in descending and ascending carefully. At times he must cease in his descent to recover his equilibrium, and if he experiences any pain in his head, he must ascend a few feet until the pain has passed away, and then resume his descent even more slowly than before.

A slow ascent is even more essential than a slow descent, especially if the man is at all full blooded. As the pressure upon the body decreases, there is a tendency in this case for the blood to rush to the head, and serious results may be incurred unless extreme care is taken. A man of strong constitution is not advised to ascend at a greater speed than two feet a second when the depth does not exceed 80 feet. At a greater depth slower speed is even more imperative, for as the man passes to decreased pressures, he must allow the muscles and tissues of his body to be relieved gradually of the enormous pressure they have sustained.

The pupil is at first only taken to a shallow depth, but this is gradually increased as he becomes proficient, until a maximum depth of 120 feet is attained. Beyond this depth naval divers are not compelled to go, but in nearly every instance they do descend to the normal limit of 150 feet. Beyond this latter depth it is not advisable for a man to descend, unless possessed of an abnormally good constitution. The pressure at this depth is enormous, being no less than 65¼ pounds of water to the square inch of the body. Even at the naval limit of 120 feet, the diver experiences a heavy pressure upon his chest and legs, and is supplied with a wickerwork crinoline to wear over his chest, to relieve the pressure upon his lungs.

The pupil is allowed to work under water for only a short time, without coming to the surface for a rest. The emergency ascent constitutes an important part of the diver's curriculum. To accomplish this double-quick rise, the diver has to inflate his diving dress.

This is done by closing the regulating valve in his helmet. The result is that the man is impelled to the water's surface like a rocket. Very often the pupil makes this impromptu ascent unintentionally by operating the valve, and he floats in an undignified manner, like an immense India-rubber ball.

When the diver has become accustomed to walking upon the rugged sea bottom, avoiding holes and projections, and is familiarized with the action of currents and tides, he is handed the various tools which he will ultimately have to use. Once more his troubles begin. Considerable practice has to be made before the diver can handle these properly while under water. There is a constant strong tendency for the tool to rise upward, and it is not until the man has handled them for some time that he can manipulate them with any measure of dexterity.

As soon as his diving education is complete and he has become proficient in the work, the diver is at once drafted to form a unit of one of the warship diving detachments. He receives a slightly increased pay for his qualification. When engaged in the actual diving work, however, he receives from $1 to $1.50 per hour, according to the nature of his task and the depth at which he is working.

The naval diver has to fulfill a wide variety of operations. He is in every respect an emergency man, and must be ready at any requisite moment. His principal duties consist of cleaning the warship's bottom, inspecting the underwater fittings, propellers, etc., investigating and temporarily repairing any damage that may be inflicted upon the hull of the vessel in an accident, recovering any valuable article that may be accidentally dropped overboard, if the depth of water is not excessive, recovering torpedoes that may have gone astray during target practice, and such work. On board the vessel the divers are allotted a station at collision quarters, ready to fix the collision mats if the exigencies demand. When the British armorclad "Victoria" sank in the Mediterranean, after being rammed by the "Camperdown," the divers were immediately at their positions with the mats, which unfortunately in this case proved abortive. Then again, if a fire breaks out on board, the diver acts the part of fireman, as he is able, with his helmet, to penetrate smoke that would suffocate the ordinary members of the fire crew.

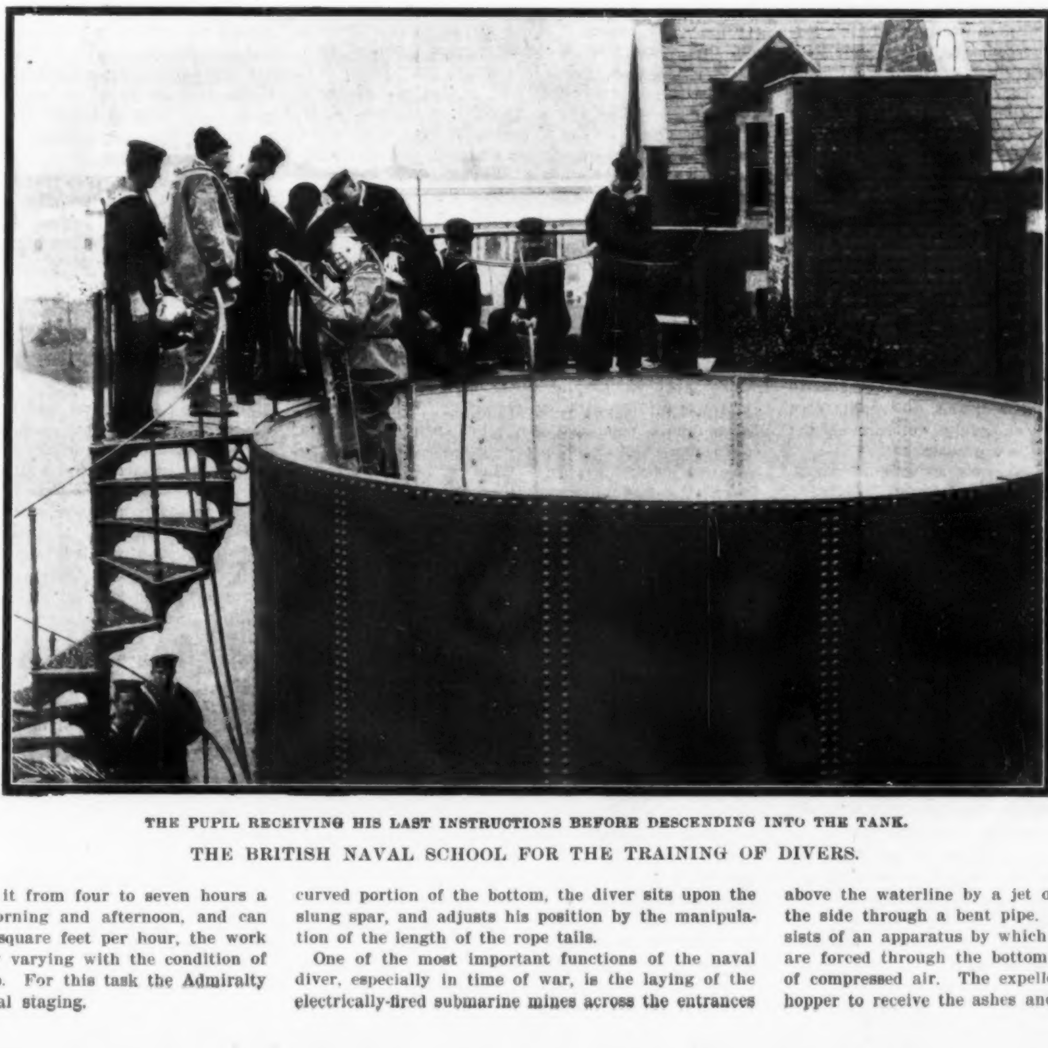
Cleaning the bottom of the ship is, however, the most common of his duties, as it is imperative, if the vessel is to maintain her high speed average, that her hull should be kept cleared of barnacles and other similar submarine growths that impede her traveling. This work is somewhat tedious. A practised and skillful man can work at it from four to seven hours a day in two shifts, morning and afternoon, and can clean from 63 to 135 square feet per hour, the work accomplished naturally varying with the condition of the bottom of the ship. For this task the Admiralty have designed a special staging.

Three spars measuring from 20 to 25 feet each in length are slung together in the manner shown in the diagram. Two of these spars are secured four feet apart to two bottom lines, and the third spar is slung by two rope tails to the lower spar on the bottom lines, and weighted with a slung shot, so as to

THE SAILOR'S FIRST LESSON IN DIVING. HE RISES ON HIS BACK.

hang vertically from three to four feet below it. When working upon the vertical portion of the bottom of the ship, the diver stands on the lower bottom line spar, and is supported in the middle of his back by the upper spar. On the latter, inside the bottom lines, two roller chocks, each about 2 feet 6 inches in diameter, are fixed at either end, so that no risk may be incurred of the upper spar becoming jammed or binding against the vessel's side, and thus disturbing the diver's balance. When working upon the lower curved portion of the bottom, the diver sits upon the slung spar, and adjusts his position by the manipulation of the length of the rope tails.

One of the most important functions of the naval diver, especially in time of war, is the laying of the electrically-fired submarine mines across the entrances to docks and harbors. Taken on the whole, however, the diver is generally regarded as an experienced jack of all trades.



THE PUPIL RECEIVING HIS LAST INSTRUCTIONS BEFORE DESCENDING INTO THE TANK.

THE BRITISH NAVAL SCHOOL FOR THE TRAINING OF DIVERS.

## SOME RECENT INVENTIONS AS APPLIED TO MODERN STEAMSHIPS.

By W. Carlile Wallace.

For the safety of the crew and for convenience in working the vessel, an arrangement possessing the following qualifications by which every bulkhead door in the vessel can be closed from the bridge in a matter of a comparatively few seconds should be installed on every ship. First, it must be possible under ordinary conditions at sea or in port to open and close the doors at will, leaving them either open or shut. Second, before the doors are closed from the bridge an automatic warning must be given to those below, after which they must close slowly, not drop suddenly. Third, after the doors are closed from the bridge it must be possible to open any individual door, the door closing automatically again. Fourth, in the event of water entering any compartment to a dangerous extent, the doors in immediate proximity to this compartment must close automatically. And last, the means adopted for closing the doors must be such that even when the mechanism is submerged it will still perform its work.

Four mediums are available for doing this work: steam, air, water, and electricity. Steam is inadmissible chiefly on account of bursting steam pipes. The pneumatic system has been tried and found wanting, to say nothing of its being too expensive. Electricity has been used with considerable success in this country, but has objections, which appear to the writer to relegate it to the second place. Among them is the possibility of blowing out of fuses or injury to the motors through overload, the risk of short circuit should the gear or conductors become submerged, and the great difficulty of locating or remedying a fault in the system. For these reasons hydraulic control seems to fulfill, more nearly than any other, the requirements necessary to a thoroughly reliable water-tight door-closing system. In the writer's opinion the hydraulic system in use on the two large Cunarders fulfills every requirement of a perfect water-tight door system.

The other inventions considered tend more toward the comfort of passengers than to their safety. The first of these is the new means of disposing of the ashes and clinkers from the stokeholds of vessels without the necessity of hoisting them above the main deck and dumping them over the side; or forcing them above the waterline by a jet of water and then over the side through a bent pipe. The new method consists of an apparatus by which the ashes and clinkers are forced through the bottom of the ship by means of compressed air. The expeller proper consists of a hopper to receive the ashes and clinkers opening into

a crusher, which breaks up the large clinkers. Below the crusher is a drum revolving horizontally in a water-tight casing. As it revolves the inside of the drum is alternately in communication with the chamber below the crusher, and the discharge opening through the bottom of the ship. While in communication with the latter, compressed air is admitted, expelling the ashes through the bottom of the ship.

Two other recent inventions of importance include a device for cooling staterooms in vessels trading in the tropics and fitted with refrigerating machinery, and a device for maintaining electrically-heated staterooms at a definite temperature irrespective of atmospheric conditions.

The cooling device consists of a pipe containing a brine coil which is supplied from the refrigerator, through which the air supplied to the stateroom is drawn by a small motor-driven centrifugal fan. The other device is the Geissinger electric thermostat, by means of which electric heaters are automatically controlled to maintain a room temperature constant within the limits of a few degrees, thus saving electric energy and adding to comfort.—Abstract of a paper read before the Society of Naval Architects.

# THE MESSINA EARTHQUAKE.

## PREDICTION AND PROTECTION.

### BY DR. THOMAS A. JAGGAR.

WHEN the man of science is asked "What caused the earthquake?" he must confess to ignorance. It was either subterranean steam, or unequal yielding to internal contraction of immense blocks of the earth's crust, or deep-seated movements of lavas slowly rising under Ætna. Or, what is still more likely, it was all three of these in mutual dependence. If we maintained earth observatories as we do astronomical ones, we might know, and we might perhaps have predicted and forewarned.

This new catastrophe is the thirteenth of the century, and brings the death-list to about 300,000, or 100 persons a day since January 1, 1901. An eruption of Ætna is also beginning and may still further swell the fatal roll. The record includes Guatemala, Martinique, St. Vincent, Mobile, Galveston, San Francisco, Valparaiso, Jamaica, Kartaghan, India, Calabria, Vesuvius, and Messina. The property loss is countless millions. Eight of these places are American. At all of them the destruction has been wrought by natural agencies. In the cases of Mobile and Galveston, there was definite prediction by the Weather Bureau. This office, which systematically records the movements of the atmosphere at widely distributed stations, is now recognized as one of the most efficient, valuable, and humane scientific organizations in the world. Similar meteorological establishments are maintained by all civilized nations. The other disasters were occasioned by volcanoes or earthquakes. The coast-lines of the world are dotted with volcanoes, and no region is known which is exempt from earthquakes. No geologist in the United States would venture to deny, for example, the statement that New York city is just as liable to a great earthquake disaster as was Charleston in 1886. With these facts before us, it would seem justifiable to call science to account for its attitude with regard to the lithosphere (or rock-crust) as contrasted with its point of view concerning the atmosphere. Sometimes a great affliction, like this which has stunned and mutilated Italy, may work beneficently by stimulating men to a new vision of their usefulness.

A great convention of American geologists has just completed its deliberations in Baltimore. All of these men are interested in earthquakes, but probably not half a dozen members of the society have any technical or mathematical knowledge of them, and not many more have ever experienced one. The idea that such experience is important for a geologist would be scouted as a jest. Many of these men are teachers in universities. If a Martian astronomer were to appear suddenly among them, after returning from a visit to the Lowell observatory at Flagstaff, where his own existence had been so wonderfully interpreted, the following dialogue might be expected:

"Where you know the heavens so well, of course your own earth is to you as an open book?"

"Yes," reluctantly.

"You have observatories for the recording of all earth phenomena?"

"No."

"What! Did you not learn everything about local terrestrial motions before you studied the stars?"

"No, we do not know anything about terrestrial movements."

"Do you mean to tell me that you have not many instruments for observing them?"

"We have the seismograph, but none of us understands it, and as for other earth motions, all we know we have learned from the physicist and the astronomer."

"But you live on the earth, and have to meet every crisis as it arises; can you foretell nothing?"

"Well, you see, we don't think of it that way. We treat it historically, and make notes, and use a hammer and a compass, and are very much interested in the bones of Jurassic reptiles and in making maps of the rocks, and in finding out all about iron and coal. But we have no such precise knowledge as the astronomer."

"But surely, in teaching your young men in the universities, you begin by precise instrumental study of the present earth and its processes, and have a vast accumulation of experience concerning those processes, in the form of tables, measurements, formulæ, curves, diagrams, and computations?"

"No, almost nothing has been done in accumulating experience or empirical data, *except by the Japanese*. When a volcanic eruption or an earthquake occurs we send a geologist to study the results, and he writes a thick and learned report. We do not know anything about what the conditions were during the months before the disaster. We teach our young geologists first a little physics and chemistry, and a few generalities about earth process, and then set them to work mapping ancient rocks. The highest development of geology is the unraveling of the history of the past. We haven't time to go into prediction and humanistic geology."

The above is not exaggerated. The blame does not rest with the geologist, it rests rather with the haphazard growth of the science. The very proximity of the earth has made terrestrial observation and measurement difficult, in view of the littleness of man. This plea, however, can no longer be urged in extenuation of the neglect of the study of earth process. We have a considerable knowledge of physical science, and there are many instruments applicable to the earth. There is a very precise science known as geodesy, which has for its object the determination of the figure of the earth. There is geology, which aims to decipher earth history. Between these two there is needed a new science, many phases of which are now being studied, and this might well be named geonomy, the science of the laws which govern the earth.

There is one grave difficulty in the way of rapid development of this science, and that is expense. It is a science that calls for the establishment of observatories in many lands. These observatories will have for their objects the study of changes which are going on in the crust of the earth under them and the relations of those changes to astronomical and meteorological changes. The new science, like astronomy and the study of the atmosphere, deals with moving things and so requires continuous local records, through weeks and months and years. Seismographs, microphones, magnetographs, gravity, pendulums, pyrometers, tromometers, gas-collecting apparatus, and many special instruments are needed.

The Japanese have taken the lead, and their island empire is girdled with observatories. The writer has before him a pamphlet, in English, printed in Tokio in October, 1908, containing eleven contributions to practical seismology by a Japanese investigator, F. Omori, the first of which bears the significant title "On the Fore-Shocks of Earthquakes." Dr. Omori declares, "My belief is that a large destructive earthquake will be foretold in its epicentral region by some fore-shocks," and this belief he substantiates by exact instrumental proofs.

With reference to Sicily, it is well to make note of the fact that an American volcanologist, Frank Alvord Perret, has predicted disaster on Mount Etna for two years past. Mr. Perret, who was decorated by the Crown of Italy for his splendid service to science and to humanity on Vesuvius in 1906, wrote in the World's Work of November, 1907:

"By the rational methods of scientific research, we know that a great eruption of Mt. Etna is impending, the only uncertainty at present being which side of the mountain will break open."

Great volcanic eruptions are preceded by great earthquakes, and the Messina disaster of December 28 comes on an earthquake date ("terrestrial maximum of gravitational stress") actually platted in advance by Mr. Perret on his diagrams for 1908. Like Dr. Omori, he is a man whose whole time is unselfishly devoted to these studies, but he has no observatory and no adequate means of support. A few business men in Springfield, Mass., last year came valiantly to his aid, and now their foresight is worthy of all honor. When young men think of making science their life-work, it would be well to remember Pasteur, and to consider carefully whether the highest development of the investigative faculties may not concern itself with humane rather than with historical motives. To those who will give time and money to the establishment of earth observatories, there will come by way of reward some of the most astonishing discoveries of the twentieth century.

Plans have been prepared in Boston for an earthquake proof observatory and museum, built on Japanese lines, to be equipped with instruments for measuring earth tremor, earth waves, earth sounds, earth tilt, earth gravity, and earth magnetism.

It is proposed to secure an endowment which will provide for expeditions as the most important work of the observatory, whereby trained men will be sent to volcanic lands to carry on research which may not be done at home. The Geological Society of America has passed urgent resolutions strongly recommending "to governments and to private enterprise the establishment of volcano and earthquake observatories." What should be done in New York? It may be well to state briefly the vision of what *could* be done to set an example to the world: Provide $4,200,000. Erect ten small observatories costing $20,000 each, in New York, Porto Rico, Canal Zone, San Francisco, Alaska, Aleutian Islands, Philippines, Hawaii, Scotland, and Sicily. With $200,000 per annum, the income of four millions, supply each observatory with $10,000 per annum to maintain its director, assistant, and expenses, and reserve $100,000 for the central office for administration, exploration, and publication. Define the objects of the work to be direct measurement and record of earth process with a view to the benefit of humanity. Define three immediate goals for the investigators: (1) Prediction of earthquakes; (2) prediction of volcanic eruptions; (3) engineering and construction in volcanic and seismic lands. The objects of the two European stations are to cover the important volcanic fields of Iceland, the east Atlantic, and southern Italy, and to keep in touch with the advance of European science. The work would be strictly American, and if it were carried out, it would be epoch-making in the history of science.

* The Nation.

---

**A new compound** which is a direct combination of antimony and nickel has been formed by M. Vigouroux, of Paris. This body has already been found in nature as an antimonide of nickel. He passes the vapors of trichloride of antimony, heated in a crucible, upon nickel in the powdered state contained in a porcelain trough inside a glass tube which is heated. The nickel absorbs the antimony in this way, and as a result there are formed small crystals of the new compound. A heat of about 800 degrees C. is used in this case. The body which is thus obtained appears in the form of a metallic powder of a brilliant and crystalline character, having a violet-red color. It is non-magnetic and its density is 7.70 at the freezing point. Upon heating it to 1100 deg. C. it is melted and the resulting mass has a metallic aspect of a reddish color. It begins to decompose at a higher heat of 1400 degrees and sets free antimony. At a low red heat, chlorine attacks the new compound, producing a brilliant glow, and oxygen has the same effect. Sulphur destroys it before having reached the melting point. Hydrochloric and dilute sulphuric acids have no noticeable action upon it, but concentrated and hot sulphuric acid gives a strong effect, giving off sulphurous gas. Nitric acid has a like reaction, with formation of nitrous vapors. Melted alkalis have scarcely any effect upon it. Chlorate of potash gives a brilliant incandescence when decomposing it.

# LIEBIG AS A TEACHER.

## A WORD PICTURE OF THE GREAT CHEMIST AT WORK.

PROBABLY the most original and most fruitful part of Liebig's life-work—not forgetting the extraordinary number of his discoveries and their important bearing on theory and practice—was the introduction of laboratory instruction. None of the great chemists of that period—Berzelius, Gay-Lussac, Chevreul, Thénard, Davy, Faraday, Mitscherlich, or Klaproth—had ever thought of making his laboratory an instrument for teaching.

The fruitfulness of this innovation was very soon fully demonstrated by the active part which the students in Liebig's laboratory at Giessen took in the advancement of science; and the other German universities saw themselves forced to follow the example of Giessen in establishing special professional chairs in chemistry and providing suitable laboratory equipment. Thus the modest little laboratory opened at Giessen in 1825 was the seed from which sprang that wonderful growth, the modern system of training the hundreds of chemists annually sent out from our universities at the present day.

This introduction of practical laboratory instruction displays a feature in Liebig's character, which comes out prominently in much of his work, namely, his disposition to apply every new observation for the benefit of mankind. Witness his meat infusion for the sick, his meat extract, and the directions for the most effective method of cooking meat, which he appends to his classical researches on the constituents of meat. In the same connection we note his prescription for an infants' food resembling as nearly as possible mother's milk, his remedy for the "souring" of bread, his baking powder, his efforts to introduce silvered mirrors in place of those prepared by the deadly amalgamation process, and lastly his relentless campaign for reform in agricultural methods.

In the early period of his teaching activity Liebig had to work out his own method of laboratory instruction, as there were no precedents to follow. We quote Liebig's own words, from his autobiography:

"My greatest difficulties, as the number of students increased, were with regard to the practical instruction. In order to teach many at a time, it is necessary to have some ordered plan or graded system, which requires to be thought out and tested. The outlines published later by several of my pupils (Fresenius and Will) represent in the main the course which was followed at Giessen. It is now introduced in nearly all chemical laboratories.

"The preparation of chemical products was a subject to which I gave particular attention; it is much more important than is ordinarily supposed. There is no other way of becoming familiar with the manifold chemical properties of a body than by preparing it from the raw materials, and then converting it into its various compounds. By the ordinary methods of analysis the student is not taught how useful the process of crystallization, when aptly employed, is in effecting separations, nor does he come to realize the importance of a familiarity with the peculiarities of various solvents."

The curriculum which Liebig introduced is the same as that commonly in use at the present day. The student was first made familiar with the properties of substances and with chemical reactions by the aid of qualitative analysis; he passed from comparatively simple to more complex mixtures, and then to quantitative determinations. The carrying out of preparations next gives the student more detailed knowledge of the chemical behavior of substances, and gives him familiarity with the chemical literature. When the student has acquired the chemical habit of thought and a fair facility in chemical manipulation, his training is brought to a conclusion by the solution, worked out as far as possible independently, of some problem suggested as a rule by the teacher.

Liebig's presentation was very peculiar and exceedingly captivating, although his delivery was not particularly fluent or polished. In fact, he spoke somewhat haltingly and without very great regard to rigorously correct style, as if he were expressing some observation or law which had just presented itself to him for the first time. It is this directness which fascinated his audience. Sometimes he would stop short in his discourse, his eyes gazing into the distance. In the course of a lecture experiment or of some explanation to the class a new idea had struck him; for a spell, time and place were forgotten, as he followed his train of thought, until suddenly the fact that he was before an audience returned to his consciousness. In conversation, too, he would sometimes stare at the person to whom he was speaking, often very much to the latter's embarrassment, especially if some point had been brought up that suggested a new train of thought. He would follow up such an idea in silence, without taking his eye off the person with whom he had been conversing. It is related that one of the boys in the family of some friends that Liebig had been visiting remarked, referring to such an occasion on which he had been the victim: "I was dreadfully tempted to put out my tongue at him, just to see if he would notice it!" Liebig used to devote great care to the preparation of his lectures. It must be remembered that in those days there were no works available which could serve as guides in arranging lecture experiments. Many of these found in all modern text-books of experimental chemistry can be traced back to Liebig's lecture note-book.

As regards the form and substance of Liebig's lectures, they were characterized by great simplicity of expression and a thoroughly objective treatment of the subject-matter. His endeavor always was to bring out as emphatically as possible the essentials, while avoiding all unnecessary complications. Brilliant experiments, which served no purpose but to astonish or amuse the audience, might be looked for in vain. Every experiment had the definite purpose of demonstrating some essential property of a body, or of illustrating some important process. For this purpose the simplest means were invariably chosen—a precaution which is highly essential for lucidity, but the importance of which is not always realized by lecturers.

Liebig was absolutely truthful. He would never have countenanced any deception, however innocent, of his audience.

Endowed in a high degree with the faculty of precise observation of the essential and characteristic, he sought to develop the same trait in his pupils. If any question arose about the nature of a substance he would often settle it by performing a test before the eyes of a student without saying a word, letting the experiment speak for itself.

After a suitable curriculum had once been determined and tested by several years' experience, Liebig devoted himself almost exclusively to the guidance of more advanced pupils. His creative mind was incessantly occupied with large scientific problems. The details of such investigations he gave into the hands of pupils, who had shown themselves capable of carrying out independent research. Frequently, too, Liebig's extended literary activity led to problems which were intrusted for solution to his pupils.

Liebig himself has given a description of the instruction in his laboratories:

"Regular instruction in the laboratory was given only to beginners, and was in the hands of my assistants. My special students learned only a proportion as they themselves contributed. I set the problems and watched the developments. No actual directions were given. Every morning each student reported to me on his work of the previous day, and on his plan for further advance. I would acquiesce, or state my objections, but each man had to pick out his way himself. All men were kept closely in touch by daily intercourse with each other's work, and thus all learned from one another. In winter we met twice a week, and I gave a review of the main questions of the day. It was chiefly a report on my work and that of my students in its relation to the investigations of other chemists.

"We worked from dawn to night-fall. Diversion and amusements there were none at Giessen. The only complaint, oft-repeated, came from the janitor, who had a great deal of trouble getting the men to leave the laboratory in the evening when his time for cleaning up came."

A particularly beautiful example of this "team work" of which Liebig speaks is the series of researches on the properties and composition of fats in 1840, in which a number of noted chemists won their spurs, among them Varrentrap and Lyon Playfair.

A good survey of the activity in Liebig's laboratory during the forties is given by Guckelberger. At that time the analyses of ashes of vegetable and animal products were in the order of the day. Porter, Troger, and Verdeil, who together with Dollfuss discovered hippuric acid in the blood of the ox, were at work on such analyses. Henneberg was carrying on an examination of the salts contained in fowl-blood, while Reeger was investigating stable manure. Schlieper had nearly concluded his investigations on derivatives of uric acid, and Unger had discovered guanine. Horsdorf had prepared salts of glycocol with hydrochloric acid and silver nitrate, and was engaged in the determination of the starch content of various kinds of flour by weighing the carbon dioxide evolved in fermentation of the saccharified starch. Unger was working on styphuric acid; Engenhard and Maddrell were making a comparative study of the salts of fermentation lactic acid and sarcolactic acid; Henneberg and Fleitmann discovered the peculiar modification of metaphosphoric acid. Bopp fused albumen with caustic alkali, and worked out a process for the separation of leucin and tyrosin. Liebig followed this investigation with intense interest. Everybody in the laboratory was made to observe the disgusting odor produced on acidifying the melt. Liebig went around the laboratory with a sample, which he held under each student's nose. About the same time Mensch worked out the process for the preparation of lactic acid and butyric acid by fermenting sugar with decaying cheese. Guckelberger himself worked first on salts of malic acid, and later continued Mensch's investigation on the action of oxidizing agents upon glue, etc.

During the years 1846-48 there were so many workers in the laboratory that the space reserved for general use in making preparations had to be allotted to individual students. Among these were Muspratt, who investigated thiocyanic esters; also Strecker, who examined pig's gall and the products of decomposition of choleic acid. Weidenbusch was working on thioaldehyde. Liebig himself was engaged in his classical researches on the constituents of muscle-fiber, and sarcosin, lactic acid, creatin and creatinin were subjects of daily discussion. Such, in brief outline, is the account published in a recent number of the Zeitschrift für angewandte Chemie of Liebig's work as a teacher and of the atmosphere of scientific research that reigned in his laboratory. Most suggestive and inspiring is this story of the methods and activity of the great master in chemistry.—Abstracted from J. Volhard's "Justus Liebig," Leipzig, 1909.

### CELESTIAL RANGE FINDING.

THE recent announcement that the Lalande prize has been awarded by the French Academy of Sciences to three Yale astronomers will excite an interest by no means limited to professional star gazers. Many of the problems which the devotees of stellar science seek to solve possess a fascination for thousands of educated persons, but none of them has provoked more eager curiosity than the probable distances of the stars.

Two general methods have been employed in the inquiry. One resembles that used by military men to ascertain how far away an enemy's troops or ships are. The parallax, or apparent displacement of a star as seen from widely separated points in the earth's orbit, supplies the material for this first kind of calculation. Many stars are so distant, however, that they have no parallax. Help in solving the problem is then afforded if it can be discovered that they change their relative positions as compared with their neighbors. In measuring "proper motions" an instrument called the heliometer is brought into play. For a long time the only device of that character in the United States was the one in the Yale Observatory. Dr. William L. Elkin has for years been distinguished for the application he has made of it to the task of computing stellar distances. It is upon him and two associates, Dr. Frederick L. Chase and Mr. Mason Smith, that the Lalande medal has now been conferred. Since the work done by these men is practically unsurpassed in its delicacy, their fellow countrymen may well feel keen satisfaction in the compliment paid them.

One of the conclusions which measurements of this class warrant is that a far greater diversity exists in the brilliancy of the stars than would otherwise be supposed. What was long considered the nearest star in the northern heavens (61 Cygni) is so far off that its light takes from seven to nine years to reach the earth. Multiply the distance traveled by a ray of light in a second (186,000 miles) by the number of seconds in a year ($365 \times 24 \times 60 \times 60$), and you have the distance traversed by a ray of light in a single year. Now, some of the estimates based on heliometer observations make the distance of Arcturus about one hundred and fifty "light years." It must, therefore, be several thousand times brighter than either 61 Cygni or our sun. That still other orbs are many hundreds of "light years" away is considered probable by sane astronomers. How utterly beyond comparison must their radiance be!—New York Tribune.

**The value** of flue-gas analysis was shown recently in a New York city power plant, where such an analysis indicated an excess of air. An examination of the boiler plant revealed a leaky condition of the flue dampers connecting certain boilers not in operation that was subsequently easily remedied and the operating results considerably improved.

# A BRIEF HISTORY OF WIRELESS TELEGRAPHY.*

## MILESTONES IN THE EVOLUTION OF A NEW ART.

BY R. A. FESSENDEN.

Concluded from Supplement No. 1724, page 45.

*Period* 1902-1908—*Later Developments.*—Progress in Europe since 1902 has been marked by the gradual abandonment of the elements of the damped wave-coherer system and the substitution of elements of the sustained wave non-microphonic contact type.

In 1900[51] Marconi substituted for the plain aerial an aerial with the writer's tuned local circuit or tank circuit for sending, thus obtaining a considerable increase in range of transmission.

In 1902 Marconi invented a very ingenious form of current-operated receiver, called the magnetic detector,[52] and with this combination achieved some very remarkable results.

In 1905 Prof. Fleming[53] invented a very efficient detector based on the "Edison effect" in incandescent lamps, and the observations of Elster and Geitel[54] on the rectifying effect of such an arrangement on Hertzian oscillations.

Virtually nothing was done in Europe in the way of producing sustained oscillations by the arc or high frequency method until recently, possibly because of Duddell's erroneous statement[55] to the effect that frequencies much above 10,000 could not be obtained by the Elihu Thomson arc method, and Fleming's statement[56] that an abrupt impulse was necessary and that high frequency currents, even if of sufficient frequency, could not produce radiation.

In 1903 Poulsen[57] invented an interesting modification of the Elihu Thomson arc, which consists in forming the arc in hydrogen instead of in air or compressed gas as previously done. This modification is not, however, so efficient as the older methods and gives oscillations varying in amplitude and intensity and accompanied by strong harmonics,[58] but I have considered it worth mentioning on account of the amount of interest it appears to have excited in Europe.

Some very important and interesting papers on electrical oscillations were published during these years by Oberbeck,[59] Wien,[60] Drude,[61] and Bjerknes.[62]

In America the development of the sustained oscillation non-microphonic system has proceeded steadily and it may now be said to have reached the stage of commercial practicability. On account of the amount of work which has been done it would be impossible to refer to more than a few of the recent advances.

The following are some of the later types of detectors:

The *frictional receiver,*[63] in which the waves produce a change of friction between two moving surfaces and so cause an indication.

The *heterodyne receiver,*[64] in which a local field of force actuated by a continuous source of high frequency oscillations interacts with a field produced by the received oscillations and creates beats of an audible frequency.

The so-called *thermo-electric receivers* of Austin,[65] Pickard,[66] and Dunwoody.[67]

The "*audion*" *of De Forest,*[68] a very interesting and sensitive device, which though superficially resembling Prof. Fleming's rectifier appears to act on an entirely different principle.

The *Cooper Hewitt mercury receiver,* about which

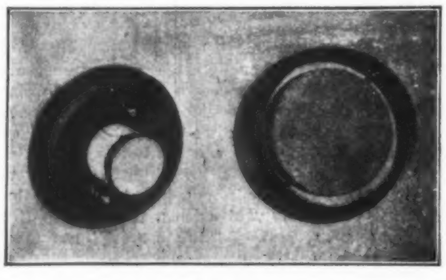


FIG. 6.

little is known but which appears to be very sensitive.

The following are some of the later methods of producing sustained oscillations:

The *substitution of a number of arcs in series having terminals of large heat capacity* in place of the single arc in the arc method.[69]

The *use of regulating or "fly-wheel" circuits* in connection with the arc method.[70]

The *method of producing oscillations* shown in Fig. 3 by using two arcs and throwing the discharge from one side to the other alternately at a frequency regulated by the constants of the electric circuit.[71]

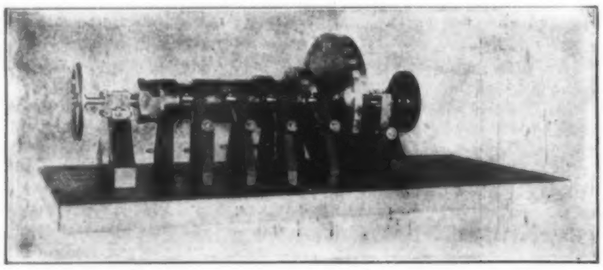


FIG. 5.

The *condenser dynamo*[72] which consists of two radially slotted disks separated by a mica diaphragm, charged by a continuous current source of potential, and rotating in opposite directions.

*Two-phase high frequency dynamo method.*[73]

*Commutator method.*[74] In this method the high frequency is produced by means of a ball rotating at high speed on the interior surface of a commutator. Shown in Fig. 4A.

The *helium arc method*[75] in which the arc is produced in helium or argon or similar gases.

The *critical pressure method*[76] in which the electrodes extend within a certain critical distance, depending upon the pressure used, so that the discharge always passes at the same voltage irrespective of the distance between the electrodes.

*Methods of Signaling. Continuous production of waves* but changing constants of sending circuit.[77]

The *inverted method* of sending and the method of signaling by sending dots, the interpretation of which is determined by similar commutators at the sending and receiving stations.

*Duplex and Multiplex Methods.*—A considerable number of these have been worked out, mostly operating either by balance methods[78] or commutators.[79] It is impossible to discuss all the various improvements, such for example as the method of indicating the busy and free state of a station, the methods of sending and receiving in one direction, the various types of aerials used for receiving the other components of the electromagnetic waves besides the electrostatic component, etc.

Fig. 5 shows the harmonic interrupter for determining the variation of intensity with change of note.

Fig. 6 shows a type of receiver described in U. S. Patent 706,747, in which the telephone diaphragm is formed of thin copper and repelled by a fixed coil having a resistance of about 16 ohms. The principle of this receiver was discovered by Prof. Elihu Thomson. It has been used for wireless telephony for a distance of 11 miles with fairly satisfactory results.

Fig. 7 shows a transformer used in the transmitting circuit. The number of primary and secondary turns can be altered continuously, and also the degree of coupling. The wire is wound off from an insulating cylinder onto a cylinder of copper, and the cylinder of copper, forming a closed circuit secondary of the transformer, annuls the inductance of that portion of the wire wound upon the copper cylinder.

Fig. 8 shows an apparatus for determining the best shape of coil for use with the heterodyne receiver.

Fig. 9 shows a group-tuned call; that is, a vibration galvanometer which operates a selenium cell and rings a bell when a call is received.

Every investigator is necessarily largely indebted to the work of others. In my own case the obligation is very extensive for two reasons, first because of the large extent of ground covered and the great number of methods developed and tested, and secondly because the phenomena dealt with had never been quantitatively investigated and it was therefore necessary so to speak to construct the foot rules and micrometers and lathes before the work itself could be begun.

First and foremost my thanks are due to Prof. Kintner for his assistance in the early work done at Allegheny. To Prof. Elihu Thomson, Dr. Steinmetz, Mr. Alexanderson, Mr. Green, Mr. Reist, Mr. Dempster and Mr. Geisenhoner of the General Electric Company, to Mr. Guy of the DeLaval Steam Turbine Company, to Mr. Fisher of the Standard Underground Cable Co.,

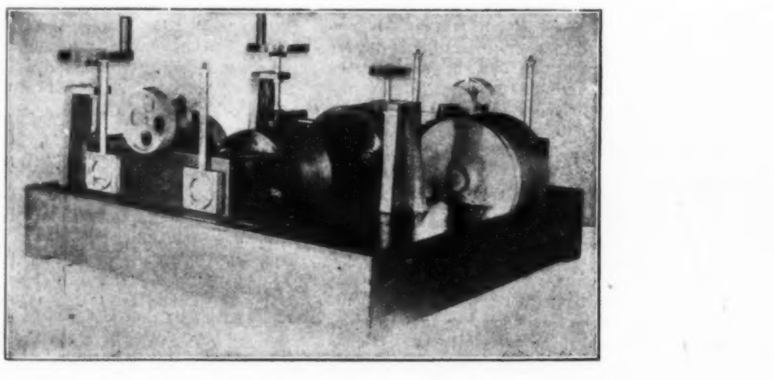


FIG. 7.



51 Marconi, Great Britain patent 7,777, April 26, 1900.
52 Marconi, Great Britain patent 10,245, 1902.
53 Fleming, Proceedings Royal Society London, 1905, vol. 74.
54 Elster and Geitel, Wied. Ann. der Physik, vol. 52, page 433.
55 Duddell, The Electrician, 1903, vol. LI, page 902.
56 Fleming, Proceedings of the International Congress, St. Louis, 1904, vol. 3, page 603.
57 Poulsen, U. S. patent 789,449, June 19, 1903.
58 Austin, Bulletin of the Bureau of Standards, vol. 3, No. 2.
59 Oberdeck, Wied. Ann. der Physik, vol. 55, 1895.
60 Wied. Ann. der Physik, vol. 8, 1902.
61 Drude, Ann. der Physik, vol. 13, 1904.
62 Bjerknes, Ann. der Physik, vol. 44, 1891, and vol. 47, 1892.
63 U. S. application, 251,538, March 22, 1905.
64 U. S. application, 271,539, June 28, 1905.
65 Austin, U. S. application, 319,241, May 29, 1906.
66 Pickard, U. S. application, 342,465, Nov. 8, 1906.
67 Dunwoody, patent 837,616, March 23, 1906.
68 DeForest, U. S. patent 836,070, Jan. 18, 1906.
69 U. S. application, 291,737, Dec. 14, 1905.
70 Ibid.
71 Ibid.
72 U. S. application, 291,739, Dec. 14, 1905.
73 U. S. patent, 793,649, March 30, 1905.
74 U. S. application, 316,521, May 12, 1906.
75 U. S. application, 351,560, Jan. 7, 1907.
76 U. S. application, 355,787, Feb. 4, 1907.
77 U. S. patents 706,747, Sept. 28, 1901; 706,742, June 6, 1902; 727,747, March 21, 1903.
78 U. S. application, 366,528, April 5, 1907.
79 U. S. patent 793,652, April 6, 1905.

to Mr. Brashear of Allegheny, to Mr. Hodge, formerly of Queen & Co., to Dr. Rosa, and Dr. L. W. Austin of the Bureau of Standards, I am in no case slightly, in many cases deeply, indebted.

I am also greatly indebted to those who have been associated with me as my assistants during the period from 1896 to 1908, i. e., Messrs. Thiessen, Bryant, Stein, Davis, Boyle, and Bennett in the experimental work, Mr. Massbendel in drafting and design, and Mr. Williams in the manufacture of the apparatus.[30]

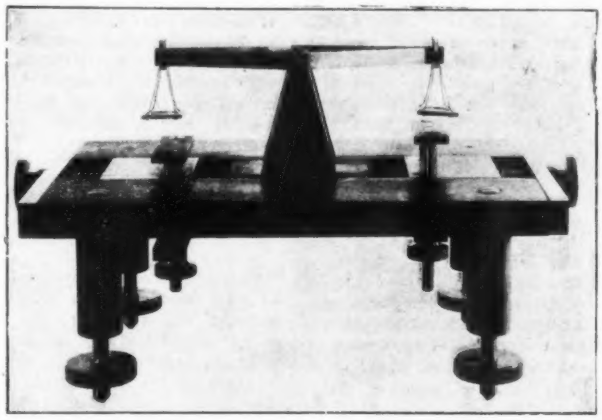


FIG. 8.

## THE MANUFACTURE OF ARTIFICIAL SAPPHIRES.

By the Paris Correspondent of SCIENTIFIC AMERICAN.

M. LOUIS PARIS gives an account of his method of producing the artificial sapphire in a paper presented to the Académie des Sciences. For some time, numerous experimenters have reproduced crystallized aluminium colored in red by means of oxide of chromium, and these appear to be identical with the Oriental ruby. However, up to the present they have not succeeded in giving a blue color to the melted aluminium in order to produce the sapphire. When we melt alumina or the natural ruby in the oxyhydric blowpipe by means of small masses gradually added to obtain a transparent product, the matter crystallizes at once, and the thickness of the surface layer in fusion never exceeds more than a few tenths of a millimeter. If we now powder this surface layer with chromium oxide, we observe that the red color produced is diffused not only in the fused layer but also in the rest of the mass, and when the globule is sufficiently small, the whole mass becomes colored. Chromium oxide thus has an affinity for the alumina which produces the color by the profound penetration, but quite a different effect is observed with the oxides which are capable of giving a blue color such as cobalt, iron, etc. These appear to be insoluble in the alumina, and instead of diffusing, they float at the surface of the melted mass without mixing with it or coloring it. After cooling we have generally a colorless mass which is covered with a dark blue crust of the oxide. It thus seems that pure alumina which contains no trace of foreign matter will not dissolve any coloring matter except chromium, as regards the above-mentioned bodies. Among the other oxides, nickel is found to color it a greenish yellow. If instead of using chemically pure alumina we introduce a few per cent of a foreign oxide, lime, for instance, the effect changes, and cobalt along with other oxides will give a blue color. But observation of the optical properties shows that these masses of alumina are not crystallized, as above, but amorphous. The introduction of a small amount of foreign matter thus permits of obtaining melted alumina in a non-crystallized state which seems not to have been formed up to the present. Only the crust of the globules has a crystalline structure. It is easy to understand what takes place when chemically pure alumina is fused with oxide of cobalt. The crystal in forming eliminates the coloring matter gradually and at the end of the fusion this latter is found almost entirely in the crust surrounding the globule. In the case of aluminium melted and non-crystallized which he obtains, the author finds that cobalt presents a great coloring affinity for the amorphous alumina. It dissolves readily and gives an intense color.

The density of melted amorphous aluminium is 3.48 and its index of refraction 1.67. Its hardness is somewhat inferior to corundum. The difference between these values and those of the natural sapphire comes evidently from the difference in physical state, and bears analogy with the differences between quartz and fused silica.

Different specimens of artificial sapphire were shown to the Academy, these being in the rough state or cut stones, and the alumina is here colored in blue by various oxides. Their color, which is of a deep hue, is so near that of the natural sapphire that expert jewelers were not able to tell the difference, and could not pick out a natural sapphire which had been placed with the artificial ones. However, it is difficult to obtain stones which have the good qualities of color, transparence and luster which are realized here. If special care is not taken in preparing the raw material, if the necessary pressure and temperature are not realized during the fusion, the specimen obtained has a tendency to split up into a multitude of fragments. In the favorable cases, stones of 20 carats can be obtained in three hours and these can be even of larger size according to the patience and skill of the operator.

## PROFITABLE DISPOSAL OF SEWAGE-SLUDGE.

ONE of the most perplexing problems confronting municipal and rural authorities to-day is the disposal of the sludge or sediment of sewage. When it is recollected that in a town of fifty thousand inhabitants the accumulation of this material is about fifteen tons per day, some idea of the difficulty involved may be realized. This sludge is the heavier particles contained in the water—aggregating about 10 per cent of the total bulk—which collects in the settling-tanks; and the general means of disposal is either dumping on agricultural land—a process involving heavy expense in cartage—or destruction by combustion in dust-destructors. The first method, while of certain economic value from the fertilizing point of view, is decidedly prejudicial to health, and cannot be carried out in the vicinity of large towns; while the second, though effective, is certainly wasteful. The question has been how to utilize this residue to the most advantageous extent in accordance with hygienic principles. The task has been frequently essayed, but the inherent difficulties have been so many as to prevent a commercially practicable solution being obtained. The general trend of these experiments has been in connection with artificial manures; but, unfortunately, the possibilities in this direction are somewhat nullified by the large proportion of fatty substances present in the sludge, which have the tendency to clog up the soil. This heavy proportion of grease is attributable to the huge quantity of soap consumed in these islands, aggregating something like four hundred thousand tons per annum, the greater part of which finds its way into the sewers. A well-known English doctor has, however, recently evolved a cheap and simple means of dealing with this sludge, whereby it is turned from a useless substance into a valuable commodity, and the successful experiments that have been made therewith by a north of England municipality have conclusively demonstrated that it not only completely overcomes the disposal difficulty, but its operation can be carried out profitably, so that a new source of revenue is open to our governing bodies. He takes the sediment which accrues in the settling-tanks, drives out the superfluous water in a press, and distills the resultant product—to which some cheap chemicals of a certain character are added—in a patent retort. Here, under the action of superheated steam, the fatty ingredients are first driven off, the oil being subsequently regained in a tower, where, under the cooling effects of jets of cold water, the fat is deposited in the form of thin white flakes like snow. The elimination of the grease and remaining water in the still leaves a brownish powder of the consistency of flour, and perfectly odorless. Seeing that this residue contains nitrogen equal to 2 per cent of ammonia, and about 2 per cent each of phosphoric acid and potash, it is evident that with the addition of a little phosphate it would constitute a rich and valuable artificial fertilizer. Its prime value, however, rests in the fact that it is composed of some 40 per cent of decomposed organic matter, which renders it of great use for the enrichment of impoverished or poor soils. It is found that one ton of sediment after subjection to preliminary pressing yields one hundredweight of grease, worth from seven pounds ten shillings to ten pounds per ton; while the fertilizer, averaging about eight hundredweight per ton of sludge in its raw condition, is found to command a price of about six shillings per ton. The cost of treating a ton of pressed sludge is about five shillings, while the total realizable value of its product is approximately nine shillings, leaving a margin of four shillings per ton. In the case of large towns the system would not only be found the most hygienic solution of a complex problem, but at the same time would prove highly lucrative, especially if the manurial residue were combined with a little p[ho]s-

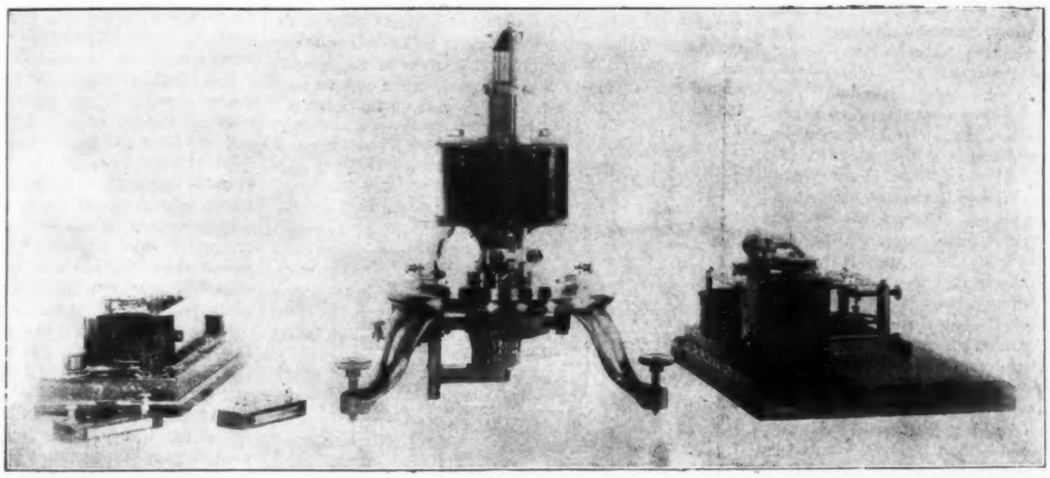


FIG. 9.

[30] Where either the idea of the invention or the means for carrying it out or both were due to an assistant, the invention has been patented in his name, and it is so referred to in the present paper.

Where the invention was made solely and entirely by the writer without assistance it has been so patented and is referred to in the paper by number only, the name being omitted to avoid unnecessary repetition.

How much the writer is indebted to his partners, Messrs. T. H. Given and Hay Walker, Jr., for the means for carrying out the work and for the wise and far-sighted policy which has enabled the development to be carried on in the most efficient way, only those who have themselves been engaged in the development of a new art can fully appreciate.

# A BRIEF HISTORY OF WIRELESS TELEGRAPHY.*

## MILESTONES IN THE EVOLUTION OF A NEW ART.

BY R. A. FESSENDEN.

Concluded from Supplement No. 1724, page 45.

*Period 1902-1908—Later Developments.*—Progress in Europe since 1902 has been marked by the gradual abandonment of the elements of the damped wave-coherer system and the substitution of elements of the sustained wave non-microphonic contact type.

In 1900[51] Marconi substituted for the plain aerial an aerial with the writer's tuned local circuit or tank circuit for sending, thus obtaining a considerable increase in range of transmission.

In 1902 Marconi invented a very ingenious form of current-operated receiver, called the magnetic detector,[52] and with this combination achieved some very remarkable results.

In 1905 Prof. Fleming[53] invented a very efficient detector based on the "Edison effect" in incandescent lamps, and the observations of Elster and Geitel[54] on the rectifying effect of such an arrangement on Hertzian oscillations.

Virtually nothing was done in Europe in the way of producing sustained oscillations by the arc or high frequency method until recently, possibly because of Duddell's erroneous statement[55] to the effect that frequencies much above 10,000 could not be obtained by the Elihu Thomson arc method, and Fleming's statement[56] that an abrupt impulse was necessary and that high frequency currents, even if of sufficient frequency, could not produce radiation.

In 1903 Poulsen[57] invented an interesting modification of the Elihu Thomson arc, which consists in forming the arc in hydrogen instead of in air or compressed gas as previously done. This modification is not, however, so efficient as the older methods and gives oscillations varying in amplitude and intensity and accompanied by strong harmonics,[58] but I have considered it worth mentioning on account of the amount of interest it appears to have excited in Europe.

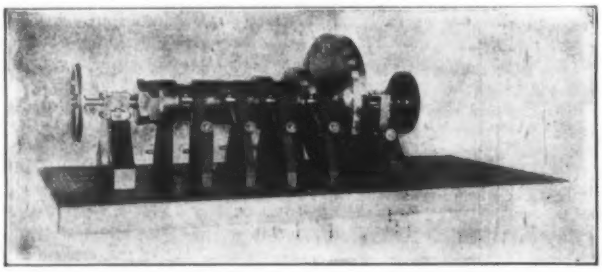


FIG. 5.

Some very important and interesting papers on electrical oscillations were published during these years by Oberbeck,[59] Wien,[60] Drude,[61] and Bjerknes.[62]

In America the development of the sustained oscillation non-microphonic system has proceeded steadily and it may now be said to have reached the stage of commercial practicability. On account of the amount of work which has been done it would be impossible to refer to more than a few of the recent advances.

The following are some of the later types of detectors:

The *frictional receiver*,[63] in which the waves produce a change of friction between two moving surfaces and so cause an indication.

The *heterodyne receiver*,[64] in which a local field of force actuated by a continuous source of high frequency oscillations interacts with a field produced by the received oscillations and creates beats of an audible frequency.

The so-called *thermo-electric receivers* of Austin,[65] Pickard,[66] and Dunwoody.[67]

The "*audion*" *of De Forest*,[68] a very interesting and sensitive device, which though superficially resembling Prof. Fleming's rectifier appears to act on an entirely different principle.

The *Cooper Hewitt mercury receiver*, about which

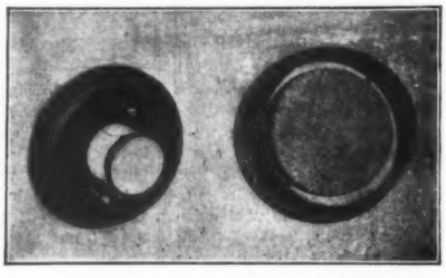


FIG. 6.

little is known but which appears to be very sensitive.

The following are some of the later methods of producing sustained oscillations:

The *substitution of a number of arcs in series having terminals of large heat capacity* in place of the single arc in the arc method.[69]

The *use of regulating or "fly-wheel" circuits* in connection with the arc method.[70]

The *method of producing oscillations* shown in Fig. 3 by using two arcs and throwing the discharge from one side to the other alternately at a frequency regulated by the constants of the electric circuit.[71]

The *condenser dynamo*[72] which consists of two radially slotted disks separated by a mica diaphragm, charged by a continuous current source of potential, and rotating in opposite directions.

*Two-phase high frequency dynamo method.*[73]

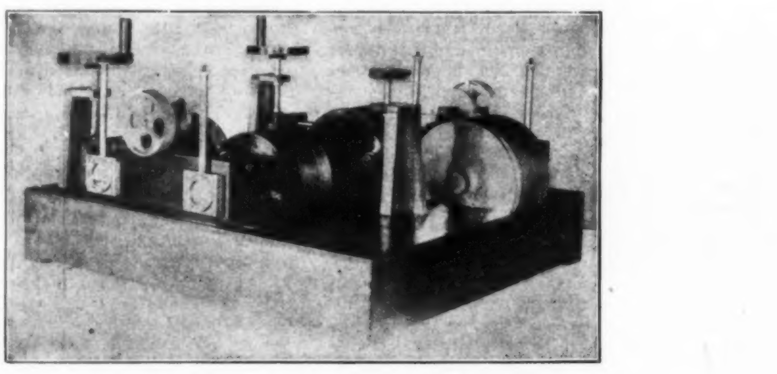


FIG. 7.

*Commutator method.*[74] In this method the high frequency is produced by means of a ball rotating at high speed on the interior surface of a commutator. Shown in Fig. 4A.

The *helium arc method*[75] in which the arc is produced in helium or argon or similar gases.

The *critical pressure method*[76] in which the electrodes extend within a certain critical distance, depending upon the pressure used, so that the discharge always passes at the same voltage irrespective of the distance between the electrodes.

*Methods of Signaling. Continuous production of waves* but changing constants of sending circuit.[77]

The *inverted method* of sending and the method of signaling by sending dots, the interpretation of which is determined by similar commutators at the sending and receiving stations.

*Duplex and Multiplex Methods.*—A considerable number of these have been worked out, mostly operating either by balance methods[78] or commutators.[79] It is impossible to discuss all the various improvements, such for example as the method of indicating the busy and free state of a station, the methods of sending and receiving in one direction, the various types of aerials used for receiving the other components of the electromagnetic waves besides the electrostatic component, etc.

Fig. 5 shows the harmonic interrupter for determining the variation of intensity with change of note.

Fig. 6 shows a type of receiver described in U. S. Patent 706,747, in which the telephone diaphragm is formed of thin copper and repelled by a fixed coil having a resistance of about 16 ohms. The principle of this receiver was discovered by Prof. Elihu Thomson. It has been used for wireless telephony for a distance of 11 miles with fairly satisfactory results.

Fig. 7 shows a transformer used in the transmitting circuit. The number of primary and secondary turns can be altered continuously, and also the degree of coupling. The wire is wound off from an insulating cylinder onto a cylinder of copper, and the cylinder of copper, forming a closed circuit secondary of the transformer, annuls the inductance of that portion of the wire wound upon the copper cylinder.

Fig. 8 shows an apparatus for determining the best shape of coil for use with the heterodyne receiver.

Fig. 9 shows a group-tuned call; that is, a vibration galvanometer which operates a selenium cell and rings a bell when a call is received.

Every investigator is necessarily largely indebted to the work of others. In my own case the obligation is very extensive for two reasons, first because of the large extent of ground covered and the great number of methods developed and tested, and secondly because the phenomena dealt with had never been quantitatively investigated and it was therefore necessary so to speak to construct the foot rules and micrometers and lathes before the work itself could be begun.

First and foremost my thanks are due to Prof. Kintner for his assistance in the early work done at Allegheny. To Prof. Elihu Thomson, Dr. Steinmetz, Mr. Alexanderson, Mr. Green, Mr. Reist, Mr. Dempster and Mr. Geisenhoner of the General Electric Company, to Mr. Guy of the DeLaval Steam Turbine Company, to Mr. Fisher of the Standard Underground Cable Co.,



51 Marconi, Great Britain patent 7,777, April 26, 1900.
52 Marconi, Great Britain patent 10,245, 1902.
53 Fleming, Proceedings Royal Society London, 1905, vol. 74.
54 Elster and Geitel, Wied. Ann. der Physik, vol. 52, page 433.
55 Duddell, The Electrician, 1903, vol. LI, page 902.
56 Fleming, Proceedings of the International Congress, St. Louis, 1904, vol. 3, page 603.
57 Poulsen, U. S. patent 789,449, June 19, 1903.
58 Austin, Bulletin of the Bureau of Standards, vol. 3, No. 2.
59 Oberdeck, Wied. Ann. der Physik, vol. 55, 1895.
60 Wied. Ann. der Physik, vol. 8, 1902.
61 Drude, Ann. der Physik, vol. 13, 1904.
62 Bjerknes, Ann. der Physik, vol. 44, 1891, and vol. 47, 1892.
63 U. S. application, 251,538, March 22, 1905.
64 U. S. application, 271,539, June 28, 1905.
65 Austin, U. S. application, 319,241, May 29, 1906.
66 Pickard, U. S. application, 342,465, Nov. 8, 1906.
67 Dunwoody, patent 837,616, March 23, 1906.
68 DeForest, U. S. patent 836,070, Jan. 18, 1906.
69 U. S. application, 291,737, Dec. 14, 1905.
70 Ibid.
71 Ibid.
72 U. S. application, 291,739, Dec. 14, 1905.
73 U. S. patent, 793,649, March 30, 1905.
74 U. S. application, 316,521, May 12, 1906.
75 U. S. application, 351,560, Jan. 7, 1907.
76 U. S. application, 355,787, Feb. 4, 1907.
77 U. S. patents 706,747, Sept. 28, 1901; 706,742, June 6, 1902; 727,747, March 21, 1903.
78 U. S. application, 366,528, April 5, 1907.
79 U. S. patent 793,652, April 6, 1905.

to Mr. Brashear of Allegheny, to Mr. Hodge, formerly of Queen & Co., to Dr. Rosa, and Dr. L. W. Austin of the Bureau of Standards, I am in no case slightly, in many cases deeply, indebted.

I am also greatly indebted to those who have been associated with me as my assistants during the period from 1896 to 1908, i. e., Messrs. Thiessen, Bryant, Stein, Davis, Boyle, and Bennett in the experimental work, Mr. Massbendel in drafting and design, and Mr. Williams in the manufacture of the apparatus.[20]

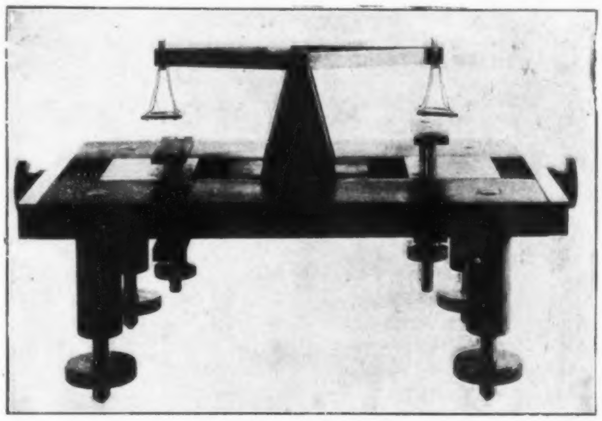


FIG. 8.

## THE MANUFACTURE OF ARTIFICIAL SAPPHIRES.

By the Paris Correspondent of SCIENTIFIC AMERICAN.

M. LOUIS PARIS gives an account of his method of producing the artificial sapphire in a paper presented to the Académie des Sciences. For some time, numerous experimenters have reproduced crystallized aluminium colored in red by means of oxide of chromium, and these appear to be identical with the Oriental ruby. However, up to the present they have not succeeded in giving a blue color to the melted aluminium in order to produce the sapphire. When we melt alumina or the natural ruby in the oxyhydric blowpipe by means of small masses gradually added to obtain a transparent product, the matter crystallizes at once, and the thickness of the surface layer in fusion never exceeds more than a few tenths of a millimeter. If we now powder this surface layer with chromium oxide, we observe that the red color produced is diffused not only in the fused layer but also in the rest of the mass, and when the globule is sufficiently small, the whole mass becomes colored. Chromium oxide thus has an affinity for the alumina which produces the color by the profound penetration, but quite a different effect is observed with the oxides which are capable of giving a blue color such as cobalt, iron, etc. These appear to be insoluble in the alumina, and instead of diffusing, they float at the surface of the melted mass without mixing with it or coloring it. After cooling we have generally a colorless mass which is covered with a dark blue crust of the oxide. It thus seems that pure alumina which contains no trace of foreign matter will not dissolve any coloring matter except chromium, as regards the above-mentioned bodies. Among the other oxides, nickel is found to color it a greenish yellow. If instead of using chemically pure alumina we introduce a few per cent of a foreign oxide, lime, for instance, the effect changes, and cobalt along with other oxides will give a blue color. But observation of the optical properties shows that these masses of alumina are not crystallized, as above, but amorphous. The introduction of a small amount of foreign matter thus permits of obtaining melted alumina in a non-crystallized state which seems not to have been formed up to the present. Only the crust of the globules has a crystalline structure. It is easy to understand what takes place when chemically pure alumina is fused with oxide of cobalt. The crystal in forming eliminates the coloring matter gradually and at the end of the fusion this latter is found almost entirely in the crust surrounding the globule. In the case of aluminium melted and non-crystallized which he obtains, the author finds that cobalt presents a great coloring affinity for the amorphous alumina. It dissolves readily and gives an intense color.

The density of melted amorphous aluminium is 3.48 and its index of refraction 1.67. Its hardness is somewhat inferior to corundum. The difference between these values and those of the natural sapphire comes evidently from the difference in physical state, and bears analogy with the differences between quartz and fused silica.

Different specimens of artificial sapphire were shown to the Academy, these being in the rough state or cut stones, and the alumina is here colored in blue by various oxides. Their color, which is of a deep hue, is so near that of the natural sapphire that expert jewelers were not able to tell the difference, and could not pick out a natural sapphire which had been placed with the artificial ones. However, it is difficult to obtain stones which have the good qualities of color, transparence and luster which are realized here. If special care is not taken in preparing the raw material, if the necessary pressure and temperature are not realized during the fusion, the specimen obtained has a tendency to split up into a multitude of fragments. In the favorable cases, stones of 20 carats can be obtained in three hours and these can be even of larger size according to the patience and skill of the operator.

## PROFITABLE DISPOSAL OF SEWAGE-SLUDGE.

ONE of the most perplexing problems confronting municipal and rural authorities to-day is the disposal of the sludge or sediment of sewage. When it is recollected that in a town of fifty thousand inhabitants the accumulation of this material is about fifteen tons per day, some idea of the difficulty involved may be realized. This sludge is the heavier particles contained in the water—aggregating about 10 per cent of the total bulk—which collects in the settling-tanks; and the general means of disposal is either dumping on agricultural land—a process involving heavy expense in cartage—or destruction by combustion in dust-destructors. The first method, while of certain economic value from the fertilizing point of view, is decidedly prejudicial to health, and cannot be carried out in the vicinity of large towns; while the second, though effective, is certainly wasteful. The question has been how to utilize this residue to the most advantageous extent in accordance with hygienic principles. The task has been frequently essayed, but the inherent difficulties have been so many as to prevent a commercially practicable solution being obtained. The general trend of these experiments has been in connection with artificial manures; but, unfortunately, the possibilities in this direction are somewhat nullified by the large proportion of fatty substances present in the sludge, which have the tendency to clog up the soil. This heavy proportion of grease is attributable to the huge quantity of soap consumed in these islands, aggregating something like four hundred thousand tons per annum, the greater part of which finds its way into the sewers. A well-known English doctor has, however, recently evolved a cheap and simple means of dealing with this sludge, whereby it is turned from a useless substance into a valuable commodity, and the successful experiments that have been made therewith by a north of England municipality have conclusively demonstrated that it not only completely overcomes the disposal difficulty, but its operation can be carried out profitably, so that a new source of revenue is open to our governing bodies. He takes the sediment which accrues in the settling-tanks, drives out the superfluous water in a press, and distills the resultant product—to which some cheap chemicals of a certain character are added—in a patent retort. Here, under the action of superheated steam, the fatty ingredients are first driven off, the oil being subsequently regained in a tower, where, under the cooling effects of jets of cold water, the fat is deposited in the form of thin white flakes like snow. The elimination of the grease and remaining water in the still leaves a brownish powder of the consistency of flour, and perfectly odorless. Seeing that this residue contains nitrogen equal to 2 per cent of ammonia, and about 2 per cent each of phosphoric acid and potash, it is evident that with the addition of a little phosphate it would constitute a rich and valuable artificial fertilizer. Its prime value, however, rests in the fact that it is composed of some 40 per cent of decomposed organic matter, which renders it of great use for the enrichment of impoverished or poor soils. It is found that one ton of sediment after subjection to preliminary pressing yields one hundredweight of grease, worth from seven pounds ten shillings to ten pounds per ton; while the fertilizer, averaging about eight hundredweight per ton of sludge in its raw condition, is found to command a price of about six shillings per ton. The cost of treating a ton of pressed sludge is about five shillings, while the total realizable value of its product is approximately nine shillings, leaving a margin of four shillings per ton. In the case of large towns the system would not only be found the most hygienic solution of a complex problem, but at the same time would prove highly lucrative, especially if the manurial residue were combined with a little p

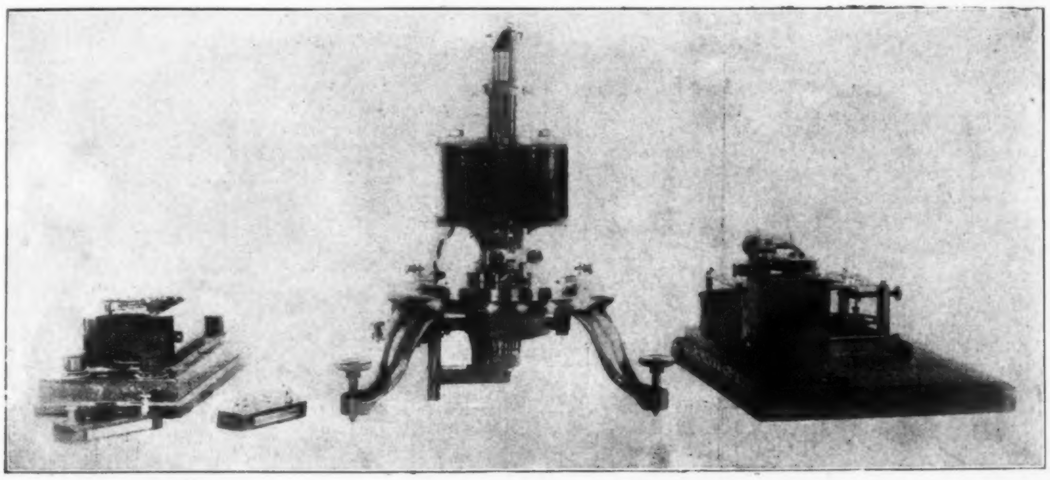


FIG. 9.

[20] Where either the idea of the invention or the means for carrying it out or both were due to an assistant, the invention has been patented in his name, and it is so referred to in the present paper.

Where the invention was made solely and entirely by the writer without assistance it has been so patented and is referred to in the paper by number only, the name being omitted to avoid unnecessary repetition.

How much the writer is indebted to his partners, Messrs. T. H. Given and Hay Walker, Jr., for the means for carrying out the work and for the wise and far-sighted policy which has enabled the development to be carried on in the most efficient way, only those who have themselves been engaged in the development of a new art can fully appreciate.

phate on the spot, which would enable it to fetch about twenty-five shillings per ton, sold direct to the farmer. —Chambers's Journal.

## SUGAR CONSUMPTION IN THE UNITED STATES AND THE SOURCES OF ITS SUPPLY.

THE average citizen of the United States consumes half his own weight in sugar every year, and the sugar bill of the country aggregates a million dollars for every day of the year.

These assertions are justified by a statistical statement just prepared by the Bureau of Statistics of the Department of Commerce and Labor, which shows the quantity of sugar produced in the United States, the quantity brought from our own islands, the quantity imported from foreign countries, and the quantity exported, showing a total consumption of from 6 to 7 billion pounds a year, the total for the latest year, 1907, being 7,089,667,975 pounds. Calculating this enormous total at the average retail price of 5¼ cents per pound, we get a total of 372 million dollars as its cost to the consumer, or more than a million dollars for each of the 365 days of the year. Dividing this total of 7,089,667,975 pounds by the 1907 figures of population, we get an average consumption for 1907 of 82 3/5 pounds per capita, which is more than one-half of the average per capita weight of the people of the country, including men, women, and children in this calculation.

One-fifth of this enormous total of 7 billion pounds, speaking now in very general terms, is produced at home, one-fifth is brought from our own islands, and the remaining three-fifths from foreign countries. Speaking more accurately, the Bureau of Statistics' statement shows that 21.3 per cent of the sugar consumption of the country in 1907 was of home production, 17.7 per cent from our own islands, and the remaining 61 per cent came from foreign countries. The home product amounted to 1,511 million pounds, that brought from the islands, 1,254 million pounds, and that from foreign countries, 4,367 million pounds. Of the 1,511 million pounds produced at home, 544 millions was produced from cane and 967 millions from beets. Of the 1,254 million pounds brought from our own islands, 408 millions was from Porto Rico, 821 millions from Hawaii, and 25 millions from the Philippines. Of the 4,367 million pounds brought from foreign countries, 3,236 millions was cane sugar from Cuba, 732 millions from other cane sugar countries, and 398 millions beet sugar produced in Europe. Meantime, 43 million pounds were exported, leaving the total consumption at home, as above indicated, over 7 billion pounds.

The sugar record of the United States in 1907 was unique in several particulars. The quantity of sugar imported from foreign countries was larger than ever before, the quantity brought from our own islands was larger than in any former year, the quantity produced at home exceeded that of any other year, the quantity exported was larger than in any year of the past decade, and the per capita consumption was the largest ever recorded, an average of 82.6 pounds for each man, woman, and child of continental United States. An equally interesting feature of this record year of 1907 was the fact that the production of beet sugar for the first time exceeded the production of cane sugar; the product of the year being, cane sugar, 544 million pounds; beet sugar, 967 million pounds.

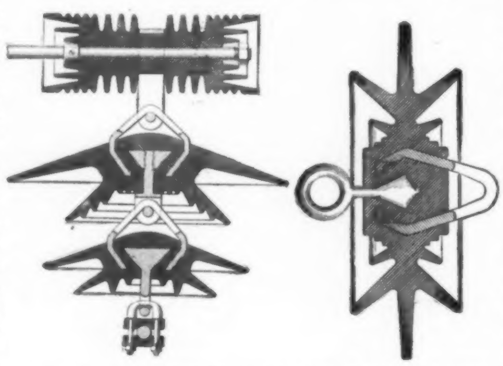
The increase in the production of beet sugar in the United States has been very rapid in recent years. A decade ago, in 1897, the production of beet sugar was about 84 million pounds, against 644 million pounds of cane sugar. Five years later, in 1902, the beet-sugar production was 369 million pounds, against 729 million pounds of cane sugar; in 1907, beet-sugar production was 967 million pounds, against 544 million pounds of cane sugar, the beet-sugar production of 1907 being greater than that of cane sugar in any year in the history of the country.

The record of sugar brought from the tropical islands now under the American flag is also interesting. The quantity brought from Porto Rico in 1907 was 408 million pounds, or more than in any year except 1906; that from the Hawaiian Islands, 821 millions, or more than in any year except 1905; and that from the Philippine Islands, 25 million pounds, or less than that during any of the past 20 years except 1901, 1902, and 1903, when the quantities were abnormally small. The quantity brought from Cuba in 1907 was also larger than in any earlier year, being 3,236 million pounds, against 2,820 millions in the former high-record year, 1904. The quantity of sugar brought from Porto Rico in 1907 was about five times as much as the average before annexation; the quantity brought from the Hawaiian Islands has about doubled since annexation, although for several years prior to that time it was being imported free of duty under the reciprocity agreement with the Hawaiian government. Meantime, although the quantity brought in from Hawaii has doubled, and the quantity from Porto Rico more than quadrupled, there has been a large increase in the home production, especially of beet sugar, of which the production in 1897 was about 84 million pounds, and in 1907, 967 million pounds.

Another interesting fact shown by the Bureau of Statistics' table is the world's production of sugar and the share thereof consumed in the United States. The table shows that the world's production has practically doubled in the past 20 years, having grown from 17 billion pounds in 1887 to 32 billions in 1907, and that while the United States consumed about 18 per cent of the total world's production of 1887, it consumed 22 per cent of the greatly increased production of 1907. A still more interesting fact shown regarding the world's sugar crop is that beets now supply one-half of the grand total produced, while 20 years ago they supplied but about one-third of the total product.

## NEW TYPES OF HIGH-TENSION INSULATORS.

THE accompanying illustrations show three types of high-tension insulators for which patents have been issued to Mr. Louis Steinberger, and which are claimed practically to cover the entire field of application of insulators to the transmission of electric power up to



FIGS. 1 AND 2.—SUSPENSION AND DISK STRAIN INSULATORS.

the highest voltage that now appears will be reached in the future. In the design of the flexible suspension type shown, provision is made not only for insulating the conductor, but also for insulating the cross-arm or support, which in effect insulates the insulator. Owing to the flexibility of this structure all direct strain on the insulating material is avoided. The dead weight of the conductor, including snow or sleet and the effect of wind-pressure, is supported by insulating material which is wholly under compression. The form of the metal suspension members makes it quite impossible for the line to drop, even though the insulating material were totally destroyed.

The disk type of strain insulator shown provides large interrupted insulating surfaces for limiting surface leakage, while the design prevents moisture, soot or dust from forming a continuous conducting path extending from one strain member to the other over the surface of the insulator. The form of the strain members and their relation to each other and to the insulating disk are such as to provide an insulator of

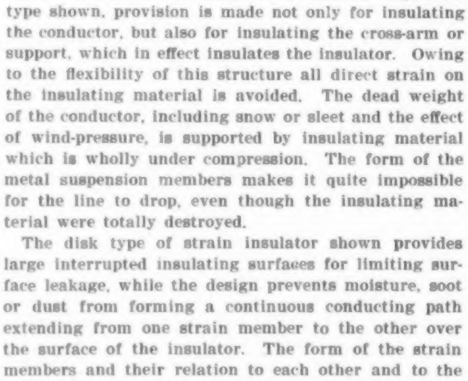


FIG. 3.—WALL INSULATOR.

exceptionally great mechanical strength combined with the highest form of electrical insulation. This disk type of strain insulator may be used separately, or a number of them may be linked together for supporting a line or used in any other desired relation where currents of very high potential are employed.

In the wall or barrier insulator shown, the several sections of which the bushing may be composed are separable; should either of the parts become injured or destroyed, it may readily be removed and a new section put in place, thereby avoiding the loss of the entire bushing. It will, of course, be evident that either one of the several bushings may be made of any predetermined length. The bushing is provided with a "protector" which shields the exposed parts from rain, snow, sleet, etc., and which may be made integral with the bushing or attached separately thereto. The central bushing is provided with detachable members for supporting the line centrally with relation to the bushing. By means of these members the central bushing may be made watertight, thereby maintaining at all times a dry surface within the bushing. Finally, an insulating locking member is provided for securing the bushing relatively to the wall or barrier, thereby obviating the trouble and expense incident to cementing a bushing into place or removing it. These bushings may be mounted into or removed from the wall very readily.

## THE NATURE AND CAUSE OF SEASICKNESS.

By DR. G. H. NIEWENGLOWSKI.

IT is now generally admitted that there are two kinds of seasickness—a purely psychical form, due to "suggestion," and a true physical seasickness, due probably to disorder of the sympathetic nervous system.

Dr. F. Regnault was the first to differentiate "seasickness of the imagination" from true seasickness. The former type is particularly that to which persons are subject who are seasick on land. Some, through the mere recollection of the suffering gone through on a previous sea journey, are seasick when they watch a vessel entering port; others are similarly affected on boarding a vessel at anchor in port; others again cannot escape seasickness whenever they travel by ship, even if the sea is as smooth as glass. In the same class are usually persons who are subject to "carsickness" in traveling by rail or in a carriage.

This seasickness by suggestion is highly contagious. Dr. Bérillon quotes his own case: "During a trip across the English Channel I was bearing up pretty well, when some friends near me started telling stories about seasickness. I felt that I was going to succumb to it unless I asked them to change the subject of their conversation."

This form of seasickness works in strange freaks. One man may invariably be sick in the Mediterranean, never on the Atlantic; with another it may be just the other way about. Still another rides unscathed through a stormy sea, but is sick in calm weather. One is immune on the open sea, but falls a prey to the sickness on lakes or rivers, while a second, who thought he had finally conquered the trouble, suffers as on his first trip, if he travels on a different type of boat. Examples might be multiplied. While the essential cause of seasickness lies in the motion of the vessel, many persons, including those subject to the "imaginary" variety of seasickness, ascribe it to other causes, such as the evil odors emanating from the hold, from the engine, from tar, etc., or to the noise of the screw, of the engine, and so on.

This seasickness by suggestion is curable, according to Dr. Maillet, who quotes a large number of cases of persons who have been cured by preventive suggestion. As a matter of fact it is purely by suggestion that some of the quaint remedies occasionally recommended have sometimes proved efficacious—though never in really rough weather. Of such remedies one may be quoted here: "Take a fish that has been found in the stomach of another fish, cook it, season with pepper, and eat it as you go on board."

While seasickness due to suggestion is curable, the same is not the case with true seasickness, for which no efficacious remedy is known. This form will, in a raging tempest, attack even sailors who have been on the water since childhood, and who are greatly surprised when they succumb to it. In this case then the attack occurs even in the face of suggestion to the contrary.

Numerous theories have been proffered to explain this true seasickness. The two that appear most rational are the theory of cerebral disturbance, which attributes the trouble to the concussions of the cephalo-rachidian fluid by the motion of the vessel; and the abdominal theory, according to which the irritation produced by the friction of the abdominal organs against one another affects the nerve ganglions, thus producing by reflex action all the symptoms of seasickness. In this connection Dr. Maillet draws attention to the observation which must be familiar to all, that the distressing sensation experienced in a sudden descent, as in an elevator or a switch-back railway, is unmistakably located in the abdomen.

The hardened sailor rarely falls a prey to seasickness, because he has, as it were, become part and parcel with the vessel, as a horseman with his horse. His body yields and instinctively follows the most irregular motions of the ship.

While there is at present no cure for seasickness, some relief can be given by applying an abdominal bandage, which diminishes the swaying of the internal organs.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Cosmos.

# NATURAL RESOURCES.

## A LESSON IN WASTE AND CONSERVATION.

BY PROF. O. N. WITT.

In recent years the exploitation of natural resources has begun to be characterized by a certain amount of prudence, which is the more remarkable as it is accompanied by an untiring zeal in the discovery and development of those resources. It appears as if this very increase in demand had created a fear that the supply would soon be exhausted, as a miser labors to increase his hoard and, at the same time, is in continual fear of losing it.

Every sensible person will rejoice at this tendency away from the reckless prodigality of the past and will do his utmost to obey and to further it, but here, as everywhere, it is possible to go too far. This is true especially in regard to the productions of animate nature, the supply of which is renewed at regular intervals, and which therefore cannot, like mineral wealth, be squandered once for all.

Even in regard to animal and vegetable products a distinction must be made between destructive exploitation and rational cropping. The latter, even in the case of the productions of unassisted nature, is not destructive, but forms the surest foundation for the prosperity of a commonwealth. For animal and vegetable products are destined to perish and decay in a short time, whether we make temporary use of them or not. Although we gain by such use, nature does not lose. Crops left ungarnered are decomposed by a slow process of oxidation. Consumed as food they are also oxidized and restored to the soil and the atmosphere in the products of digestion and respiration, so that the final result is not altered by our forced loan from nature. In destructive exploitation, on the contrary, we are defaulting and dishonest debtors, for we take not only the product but also the machinery of its production, and the last named part of the debt is never repaid. The distinction between the two forms of loan is not always made, and in former times the existence of this distinction was not suspected.

The face of the earth has been greatly changed by human agency. The forests that once covered the continents have been, to a considerable extent, replaced by farms, gardens, and buildings. If this transformation is effected in a proper and rational manner no objection can be made to it. Far more violent changes are often made by natural agencies, without human assistance. Extensive inundations and volcanic eruptions cause disturbances of equilibrium from which the earth does not recover in thousands of years. How insignificant, in comparison with such convulsions, is the destruction of a forest to make room for a wheat field or a coffee plantation!

But when steep wooded mountain sides, where the fertile soil is retained only by the roots of trees, are ruthlessly stripped of their forests, so that storms soon wash away the scanty soil, leaving the rocks naked and barren and at the same time overwhelming the fertile valley below with a flood of detritus, an unpardonable crime is committed. This was done by the Greek colonists in the once densely wooded but now stony and hopelessly impoverished island of Sicily. The Venetians subsequently, in unwitting reprisal, wrought similar havoc in Greece and the islands of the Aegean Sea, which were covered with noble forests as late as the 11th century.

If the Venetians had merely taken the largest trees as material for their galleys and had spared the young growth, Greece might to-day be one of the most richly wooded lands on earth, but, in order to facilitate the transportation of the great logs to the sea coast, they burned the young growth and thus converted these splendid forests into barren stony deserts. This was destructive exploitation in the worst sense of the term.

Similar deeds are done to-day, not in civilized European countries where the land is protected by the government, but in distant regions which, now the sport of the foreign exploiter, are destined some day to have settled populations which will require a sort of unimpaired fertility. To preserve those lands for the rational use of future generations is the sacred duty of their temporary possessors who, in these civilized times, ought to be able to distinguish between conservative and destructive exploitation. This applies with especial force to our [German] African colonists, in whom the first symptom of tropical mania is frequently forgetfulness of this distinction.

Devastation is wrought not only by greed, but also by scientific and artistic zeal. Many otherwise well-bred and sympathetic men and women are converted by their love of nature into angels of destruction. Many beautiful European flowers and insects have been "collected" so ruthlessly that they have been almost exterminated. Among these flowers are the lady's slipper (*Cypripedium calceolus*), the Turk's cap lily (*Lilium martagon*) and many others, while the Alpine rose and the edelweiss owe their preservation to their habit of growing in inaccessible places. In 1883 an enthusiastic lover of nature planted the remarkable American pitcher plant (*Sarracenia purpurea*) in sequestered nooks in the Thuringian forest and rejoiced to see it flourish and multiply with each succeeding year. One day all the plants vanished. Long afterward their disseminator happened to read an article written by a man calling himself a botanist, who described his remarkable discovery of *Sarracenia* in Thuringia and boasted that he had carried off every plant he could find.

Every botanical collector should always observe the rule to leave more plants, of a given species, than he takes away. Teachers who take their pupils on botanizing excursions, letting loose hordes of ravagers upon defenseless nature, should observe and inculcate this rule with especial care.

In enlightened lands movements are being made toward the preservation of "natural monuments," a name which has been extended to include, besides caves, peculiarly shaped rocks and giant trees, rare plants, and especially plants found only in a few small districts. But the protecting fences and warning placards should be erected in the hearts of men as well as around the monuments. It is the duty of the schools to instill in their pupils veneration for the masterpieces of nature.

No reader of the above lines will regard me as an advocate of the reckless exploitation of natural resources. But, as I have already observed, it is possible to go too far in the opposite direction and to bring the charge of vandalism against men who are really making a rational and legitimate use of the bounties of nature. We often read and hear complaints of the destructive methods employed in the collection of India rubber in northern Brazil, Guiana, and southern Venezuela. Here the chief source of rubber is the *Hevea Brasiliensis*, a large tree of the natural order of *Euphorbiaceae*. The trees are sought and found in the immense virgin forests of the Orinoco and Amazon region. By making gashes in the bark a milky sap is obtained, which yields Para rubber, by far the best sort. The trees are tapped repeatedly, until they are killed. It is often asserted that the species will soon be exterminated and the recent great increase in the price of rubber has been adduced as a symptom of exhaustion. These prophets of evil are as ignorant of commerce as they are of the tropics. Increase in price may be caused by increased demand, as well as by diminished supply. The increase in the price of rubber is due chiefly to the growth of the automobile industry and the resulting demand for pneumatic tires, for which the best Para rubber is required. How shall this rubber be obtained? By cultivating the trees in plantations? This has long been done, in Bolivia, Colombia, Mexico, Ceylon and Java, and more recently in German Africa. The Para rubber tree has proved very amenable to cultivation, and improved methods of harvesting have produced large quantities of nearly colorless rubber which commands a higher price than the Brazilian product. But this does not prove that the collection of the uncultivated rubber should be abandoned. Why should the trees be allowed to die and rot without affording any benefit to mankind?

The rubber tree is in the stage of transition from the state of nature to the state of cultivation. The same thing is happening to all useful plants of the tropics, as it happened long ago to our common cultivated plants. Although it is being planted and cultivated more and more extensively, it is still necessary, in order to supply the demand for Para rubber, to seek out and utilize the trees growing wild and isolated in the forests of Brazil. The half savage "peon" who earns his living by this arduous work, incidentally acts as a pioneer of civilization by making roads through the primitive forest and gradually making it fit for the transformation into arable land, which is its ultimate destiny. This slow process of development appears to me preferable to the usual radical method of burning mile upon mile of forest. The latter course is destructive exploitation in its true name.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

**Goldbaum and Smith**, in the Trans. Am. Chem. Soc., describe an electrolytic method for the analysis of alkali and alkaline earth halides, including the ammonium salts. The method is based on the use of a mercury cathode, and a rotating silver anode. After determining the decomposing E. M. F. of rubidium and cæsium, they were able to separate sodium from a mixture containing salts of ammonium, potassium, rubidium and cæsium; also potassium from cæsium and rubidium, and rubidium from cæsium. The results were exceedingly accurate, and the time required very short.

### THE LIFE OF THE INVISIBLE WORLD.

By the Paris Correspondent of SCIENTIFIC AMERICAN.

That there is an invisible living world which lies beyond the reach of microscopic research has not perhaps been brought out as prominently as it should be. No doubt it is generally supposed that the microscope reveals the most minute forms of animal life which exist and that there should be anything beyond this would be likely to awaken incredulity in the minds of most people. Assuming that there should be invisible forms of life which we are unable to see even with the most powerful microscopes, we may ask ourselves, where does the limit of the organic world lie? Is the subdivision of living organisms continued indefinitely? If not, where does it stop, and what is the smallest actual living organism?

Dr. Roux of the Pasteur Institute and the successor of the illustrious Pasteur, together with Nocart and Borrel, was the first to perceive the existence of the invisible bacteria, about 1897. These organisms they were able to handle in the mass and to observe their growth in colonies, but they were never able to see them as individuals even by the aid of all the instruments they could bring to bear upon this research. In this respect they were like blind men before an invisible universe. While we know that such life exists we are unable to see the organisms which compose it. Doctor Marechoux, of the Pasteur Institute, has arrived at some interesting results. Roux, Nocart and Borrel had the idea of constructing sacks of collodion in which the grain of the material was too fine to allow any of the usual microbes to pass through, as was found by a series of tests. The sacks were then filled with a culture bouillon which was treated for development of germs by adding to it a serum obtained from cattle who were affected with peri-pneumonia. The sacks thus treated were introduced into the peritoneum of rabbits, for it was in the observation of this malady that the investigators commenced to suspect the presence of the invisible germs. At the end of a certain time they removed the sacks and analyzed the liquid. They found it to be troubled and it was seen that the microbes had developed. Then it was asked what was the nature of such organisms and their form, and this led them to devise new microscopes in order to perceive them. After the vertical rays they tried the horizontal rays according to the principle that makes us see the dust particles when the rays of the sun pass across them. After the use of white light they tried the use of violet and ultra-violet light, but their efforts in this research proved to be unavailing and the organisms persisted in remaining invisible.

An advance in the research was made by Dujardin-Beaumetz, who prepared the culture of the microbes in tubes, which, instead of a liquid medium, contained a solid medium. In this way he caused colonies of the microbes to emerge to the surface. These colonies were so numerous that they could be perceived by the naked eye, but when they were examined under the microscope with the hope of seeing the individuals of the colonies, it was found impossible to perceive them.

Nevertheless, science has made a considerable progress in this direction and we are now aware that a great number of diseases have their origin in the action of invisible germs. Such are the bovine pest in the case of animals, the aviary pest which causes such harm to poultry, and in the case of plants there are certain maladies of tobacco, among others. For the human system we find yellow fever and rabies bacteria. However, up to the present time it does not seem to have been possible to cultivate these microbes in the usual way. This problem has now been solved by Dr. Marechoux, as he showed in a recent communication which he made to the Académie des Sciences. This communication awakened great interest and it was considered that a step in advance had been made in our knowledge of invisible organisms.

When we place a minute particle of a virus in a culture tube we always obtain a liquid which pos-

sesses the properties of the virus and causes death. It is impossible, however, to perceive otherwise than by inoculation upon animals, that there exists a true culture, for in the tubes as well as in the blood of the animals the microbe remains invisible. However, when we take a minute part of the contents of the first tube and place it in a second culture tube the development goes on as in the first place. When this operation is repeated successively in ten different tubes, one after the other, making ten dilutions of the substance, we find that the medium remains virulent, and thus we are obliged to admit that the microbe has been cultivated in each of the tubes. If it were not so, and there was a simple dilution of the virulent substance, such a dilution would represent the original virus dissolved in many millions of times its volume of liquid. A small portion of such liquid could not therefore cause the death of an animal. Such a process of culture of the invisible microbes is the first step in a field of research whose importance cannot be over-estimated, especially from the standpoint of our conception of the organic universe. At the present time it is impossible to say what may be the outcome of future research in this direction, but it is being actively carried on by Dr. Marechoux and other workers who hope to achieve some interesting results in the future. Such organisms exist, of course, in the human body, and some of them may be useful to us, as has been found for the larger organisms, while others have a harmful action. There are, no doubt, a great number of varieties of such organisms. It will cause some reflection when we think that we carry about with us an invisible organic world of which we have practically no knowledge whatever; and it will take many years of research before we have even a small amount of light upon the question.

## SCIENCE NOTES.

**In Kunick's** vacuum evaporator (patented) the vacuum chamber is cylindrical and contains an eccentrically placed drum which is coated, by means of a trough and roller, with the liquid or semi-liquid substance to be evaporated. The drum is heated internally with live, exhaust or low pressure steam, according to the temperature desired. The vapor thus generated is partly condensed by refrigerating pipes, placed parallel to the axis of the drum, and the remainder is drawn off through pipes connected with an air pump. The dried substance is automatically shaved off the revolving drum by a fixed blade which delivers, in the form of a thin continuous sheet, to a conveying helix, and leaves the vacuum cylinder through an ingenious outlet, by which the vacuum is maintained, despite the continuous operation of the apparatus.

**"I confess,"** said Dr. Haldane, in an address to the British Association for the Advancement of Science, "that as a physiologist I am struck with amazement at the manner in which heredity is often discussed by contemporary writers who endeavor to treat the subject from a mechanistic standpoint. Sometimes, indeed, the germ-cell is acknowledged to be a complicated structure, but at other times it is treated as a 'plasma,' which can be mixed with other 'plasma,' divided, or added to, as if for all the world it were so much treacle! I have tried to place clearly before you the assumptions in connection with heredity which to my mind make the physico-chemical theory of life unthinkable, even if it be tenaciously clung to in connection with those ordinary physiological phenomena where it has proved so disappointing." The conception which is to take its place is simply the conception of the living organism, which stands, or ought to stand, in the same relation to biology as the conceptions of matter and energy to physics, or of the atom to chemistry. A living organism is distinguished by the fact that in it what we recognize as specific structure is inseparably associated with what we recognize as specific activity. Its activity expresses itself in the development and maintenance of its structure, which is nothing but the expression of this activity. Its identity as an organism is not physical identity, since from the physical standpoint the material and energy passing through it may be rapidly changing. In recognizing it as an organism we are applying an elementary conception which goes deeper than the conceptions of matter and energy, since the apparent matter and energy contained in, or passing through, or reacting with, the organism are treated as only the sensuous expression of its existence. Even the environment is regarded as in organic relation with the organism, and not as a mere physico-chemical environment. It follows that for biology we must clearly and boldly claim a higher place than the purely physical sciences can claim in the hierarchy of the sciences—higher because biology is dealing with a deeper aspect of reality. It must also be the aim of biology gradually to penetrate behind the sensuous veil of matter and energy which at present seems to permeate the organic world at all points.

## ELECTRICAL NOTES.

**The use** of a tiny gas flame or a platinum point heated to incandescence by a circuit has long been used to engrave glass by the decrepitation of small pieces, and this property may be used to a more practical extent and on a larger scale in rock cutting in tunnels and mining. A series of electric arcs on a turret at the heading is proposed for the purpose. The first attempt to pierce Hoosac Mountain in northwestern Massachusetts was by means of a gigantic turret carrying numerous chisels, the invention of Gen. Herman Haupt, but, after boring a hundred feet or so, the machine was abandoned and the 4.71 miles of tunnel made by drilling and blasting. It was a long time before this tunnel was lighted by electricity, as there was not at the time any insulated wire in the market which would resist the dampness of the tunnel.—Electrical Review.

**From a Belgian** report of the progress of electrometallurgy it appears that the cost of simple fusion of steel in an electric arc furnace of 1½ tons capacity is about $20 per ton, if the cost of electric energy is 2 cents per kilowatt hour. In large non-electric steel furnaces the cost of fusion is slightly greater than this, and in small coke furnaces it is more than twice as great. The electric furnace produces steel of very high grade and of any desired character, as the temperature can be controlled perfectly. The percentage of sulphur has been reduced from 0.146 to 0.015 and that of lead from 0.12 to 0.005 by refining steel in the electric furnace. For an electric furnace of 1½ tons capacity the total consumption of energy may be estimated at 1,000 kilowatt-hours per ton of steel if the charge is cold and about one-third as much if the charge is already fused. The thermal efficiency is very high, 50 or 60 per cent.

**Oxygen and hydrogen** can be obtained readily from water on a commercial scale by means of the new Oerlikon-Schmidt electrolyzers which have been brought out at Zurich, Switzerland. In general this electrolysis is carried out in metallic vessels having iron electrodes and using an alkaline solution, but heretofore such an apparatus was of a large size and had a great number of elements in series, needing much piping and connections. Besides being of simpler form, the new apparatus will deliver the gas at a relatively high pressure. It uses a flat electrode plate of cast iron having an outer projecting rim, while the surface carries a set of vertical ribs. Two plates are placed together to form a pair and they are separated from each other by a diaphragm of asbestos fabric. A rubber gasket around the border serves to make the combination watertight. The free space between the two plates forms an electrolytic cell, and the series is made up of a certain number of such cells which are mounted together upon three horizontal supports and all pressed together by means of a screw at one end. Each plate carries three holes and in these are inserted three long pipes which serve to carry off the gases, oxygen and hydrogen, and these are led off by piping. The smallest type of apparatus works on 65 volts and 20 amperes (2 horse-power) and has 28 chambers, using 10 gallons of liquid, and it produces 6.3 cubic feet of hydrogen and 3.2 cubic feet of oxygen per hour. As to the largest type of generator, it works on 110 volts and 125 amperes (20 horse-power) and has 48 chambers; it gives 68 cubic feet of hydrogen and 34 cubic feet of oxygen per hour. The liquid is a ten per cent solution of carbonate of potash in distilled water.

**Silundum** is another form of silicon carbide and it has generally the same properties. It is very hard; it resists temperatures up to about 1,600 deg. C. when heated in air and does not oxidize. It resists the attack of acids when cold and is a conductor of electricity, its resistance being several times that of carbon. The hardness of silundum is variable and depends on the zone around the core of the furnace in which it is produced. Material from the amorphous zone is less hard than that obtained in the crystalline zone. It may be assumed that the hardness depends on the temperature in which the material is produced. The hardness may also depend on the amount of silicon taken up by the carbon. It seems that some pieces contain more or less silicon than others, but no analysis was made to ascertain this. In regard to the fireproof qualities of silundum, it may be mentioned that at about 1,700 deg. C. the silicon leaves the carbon and combines with the oxygen of the air. Small transparent globules are formed (for instance, on a rod that is put in a circuit and heated to about 1,700 deg. by the electric current) on the surface of clear or brownish color. These globules are silicon dioxide. Parts of the silicon escape in form of a white vapor. Silundum cannot be melted, and it behaves in this respect like carbon. The electric resistance of silundum is variable and depends on the kind of carbon and its hardness. Silundum made from porous carbon has a higher resistance than when made of hard carbon. The resistance depends also on the modification of the material. If produced in the amorphous zone the resistance is generally higher than in the crystalline zone. —Electrochemical and Metallurgical Industry.

## TRADE NOTES AND FORMULÆ.

**Galvanic Metal Coating on Flowers and Insects.**—The process consists first in the employment of an albuminous fluid, with which the various objects in question are coated by immersion to protect them from metallization. Then they are dipped in a bath of about 20 per cent nitrate of silver solution and exposed to the effects of sulphureted hydrogen, in order to reduce the nitrate of silver present. Everything organic is now ready for the galvanic deposit. This reveals the slightest inequalities of the surface and minute hairs, hardly perceptible to the naked eye, are made plainly visible.

**Fruit Syrup.**—According to Kühn, a steam generator is used, a steam boiling kettle with basket and inserted filter, a separated stirring apparatus and a container for boiling water, which at the end of each operation can be used for the purpose of automatically cleansing the kettle. The kettle having been equipped with basket and filter, we place in it 2 parts of sugar syrup, for boiling; add to this, for instance, 2 parts of fresh strawberries, allow it to boil up once and leave it to draw until the fruit has parted with all of its juice to the sugar syrup, to which it has imparted its color, fine flavor, and aroma; the basket is then drawn up and the shrunken residue of the fruit allowed to drain; the finished syrup is then drawn from the kettle into bottles and it is now ready for shipment or consumption. The residue of the fruit, on the completion of the day's work, is boiled with an equal volume of fresh fruit (in the case quoted, 2 parts) into a marmalade, for which process the stirring apparatus is available. Result of the operation: 10 parts, by weight, of fresh fruit yield about 8 parts of juice; 10 parts of sugar syrup, with 10 parts of strawberries and all other berry fruit, 18 parts of fruit syrup.

**Practical Production of Rubber (Caoutchouc) Solutions.**—The conditions governing the production of good rubber solutions, especially where they are to be employed as adhesives, are as follows: The greatest adhesive value is possessed by a solution of the best Para rubber, without any addition of other kinds of rubber. A small addition of sulphur to this solution is advisable, the rubber being thereby rendered more durable. As a solvent, use benzole. In order that the rubber may dissolve quickly and clear, it must be perfectly dry and clean, which can only be effected with the aid of good washing rolls. Cutting up with knife or scissors does not answer. Rapid solution is promoted by fine division of the rubber, which can be effected with the aid of closely set, cold rolls. As far as the quantity of solvent is concerned, we can obtain, with the same volume of solvent, solutions of widely different consistency, according to the nature of the rubber. As an aid to the production of these different solutions heat and kneading are required. A washed rubber, dried only at a moderate heat and cut up without further working, will furnish, even with large quantities of benzine, very stiff solutions. A well-kneaded rubber, in the proportion of 1 to 3, will still give a fairly thin solution, which may be explained as due to a change in the crude rubber during the heating and kneading processes. The kneading may be effected either by means of mixing rolls or by specially constructed kneading machinery. For those who make their own solutions, two kinds of rubber may be recommended—one kind made from completely unkneaded and one made from well-kneaded rubber. Both can be purchased from the rubber manufacturers in rolled form.

## TABLE OF CONTENTS.